Review of Research and Development in Forensic Science:

University Responses

Questions for researchers

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

Review of Research and Development in Forensic Science:

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University		
	Anglia Ruskin University	Substantive
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	Birkbeck College	Substantive
	University of Bristol	Substantive
	Brunel University	Substantive
	The Institute of Public Health, University of Cambridge	Substantive
	University of Canberra	Substantive
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	De Montfort University	Substantive
	University of East Anglia	Substantive
	School of Life, Sport and Social Science, Edinburgh Napier University	Substantive
	University of Glamorgan	Substantive
	University of Glasgow	Substantive
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	Glyndwr University	Substantive
	School of Applied Sciences, University of Huddersfield	Substantive
	University of Hull	Substantive
	Keele University	Substantive
	King's College, London	Substantive
	King's College Hospital Dental Age Assessment Team - 2011	Substantive
	Lancaster University	Substantive
	University of Lincoln	Substantive
	University of Lincoln	Substantive
	Loughborough University	Substantive
	Manchester Metropolitan University	Substantive
	Middlesex University	Substantive
	Northumbria University Centre for Forensic Science	Substantive
	Open University	Substantive
	Department of Statistics, University of Oxford	Substantive
	University of Portsmouth	Substantive
	University of Portsmouth	Substantive
	University of Reading	Substantive
	Psychology Department, Roehampton University	Substantive
	Sheffield Hallam University	Substantive
	Southampton University	Substantive
	Staffordshire University	Substantive
	University of Strathclyde Centre for Forensic Science	Substantive
	University of Sunderland	Substantive
	Teeside University	Substantive
	UCL Jill Dando Institute Centre for the Forensic Sciences	Substantive
	Ulster University	Substantive

	Centre for Information Operations [CIO], University of Wales, Newport	Substantive
	Aberystwyth University	Nil Response
	Edge Hill University	Nil Response
	Oxford Brookes University	Nil Response
	Royal College of Art	Nil Response
Individuals		
	Dr. Colin Aitken (RSS)	Individual, substantive response (in addition to response sent by RSS)
	David Balding (UCL)	Individual response as a researcher
	Dr. Itiel Dror, University College London	Individual, substantive response
	Professor Peter Gill (University of Strathclyde)	Individual, substantive response
	Dr Karl Harrison (Cranfield University)	This is in addition to the comments submitted via the Cranfield University response.
	Dr Kevin Sullivan (Chief Scientist's Group, FSS)	Individual, substantive response
	Professor Wesley Vernon (Forensic Podiatry)	Individual, substantive response

ANGLIA RUSKIN UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Current work in the area of forensic science lies in four principle areas.

1. Drug identification, chemical impurity and *in vitro* toxicity profiling of amphetamine type stimulants and legal highs;
2. Development of analytical methods for the recovery and identification of drugs and metabolites from stable substrates (hair);
3. Development of methods for the recovery and analysis of ignitable flammable liquids from fire debris and fire scene surfaces;
4. Development of methods for the confirmation or otherwise of provenance of historical artefacts.

Opportunities for the future include broadening the range of materials being studies through collaboration with forensic science providers both within the U.K. and overseas.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

One member of the research group led a European consortium developing a method for the chemical impurity profiling of amphetamines which involved seven forensic science providers, including the Forensic Science Service (U.K.), National Bureau of Investigation (Finland), The Swedish National Forensic Science Laboratory (SKL), and the Dutch National Forensic Science Laboratory in Rijswijk, in addition to University provision in Aarhus, Denmark, Lausanne, Switzerland and Lisbon, Portugal.

Collaboration with the Fire Prevention Agency (FPA) is currently underway and as part of our M.Sc. programme in Fire Investigation we have engaged with a number of forensic services and fire authorities in this area.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic ?

The method developed by the consortium in (2) is now used as a an amphetamine profiling method in Europe, Australia and the United States. Using this method it is possible to exchange data around profiling of amphetamines to secure more meaningful investigations and successful drug law enforcement.

Research in the forensic science area is often difficult because :-

1. The agency status of the FSS and the competitive business nature of forensic science has reduced, almost to zero, the opportunity for the major

forensic science providers to engage with long term and / or speculative forensic science research either internally or with other organisations such as universities. Any research that has been undertaken recently has been driven solely by the business need of the organisation concerned.

2. There is currently no unit of assessment for forensic science within the the Research Excellence Framework. This makes assessment and review of the forensic science research provision difficult because the work is often compared to traditional physical and biological sciences. Such direct comparisons are not always valid.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science ?

Some of the research councils, for example the EPSRC, have funding streams that support forensic science. However, the vast majority of the projects that one member of the group reviewed were very peripheral to forensic science, poorly written and would have little impact, reach and significance in the proper forensic science context. What is required is a clearer set of guidelines for such funding streams. Funds are also available through organisations such as the Leverhulme Trust, the Wellcome Foundation etc., and the European Union funding initiatives.

The principle barrier in the U.K. context is the lack of willingness of the forensic science providers to engage with Universities in meaningful research. The reasons that they state are that research does not feature within their business portfolio. Such barriers do not exist on mainland Europe, hence the success of projects such as those described in (2) above.

5. What are the important international networks and how useful are they ? Do you have any specific international collaborations you would wish to draw to our attention ?

The most significant networks from a research point of view are :-

The European Network of Forensic Science Institutes (ENFSI)

The Americal Academy of Forensic Sciences (AAFS)

The International Association of Forensic Toxicologists (TIAFT)

The Society of Forensic Toxicologists (SOFT).

These are extremely useful in establishing research collaborations, networking and dissemination of research results through their various international conferences and in the case of the AAFS the Journal of Forensic Sciences.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

None at present.

ASTON UNIVERSITY

Questions for researchers

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

   The Centre for Forensic Linguistics (CFL) was set up at Aston University in May of 2008. It was the first Centre in the world to deliberately combine research, doctoral supervision and postgraduate teaching with consultancy and professional training. Since the establishment of the Aston Centre other Centres have been developed at the University Pompeu Fabra in Barcelona and more recently at Hofstra University in New York State. Outside the University sector, the German Federal Police (the BKA) have a dedicated forensic linguistic unit and the FBI have a Written Threat Analysis unit both of which deal with similar issues. The provision of forensic linguistic analysis within the UK depends upon the University sector and principally on CFL. Forensic linguistics is taught at Cardiff University although staff research concentrates on language in the legal process and they only occasionally engage in investigative casework.

   Within forensic text analysis we are best known for our research in comparative authorship analysis and sociolinguistic profiling. Comparative authorship analysis finds points of distinction between anonymous writings and reference samples, while our profiling work identifies social and demographic characteristics of writers. We have had a series projects funded by the security services in both of these areas; in comparative work we are funded to develop techniques applicable to short-form messages such as SMS and twitter and in the profiling arena we have completed projects which help identify first language influence on non-native writers of English, which has obvious practical applications. Research is ongoing to improve our analytic techniques.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?**

   Members of our Centre are on the NPIA Experts database. As well as carrying out investigative work we have given training to police forces in such areas investigative interviewing, working with interpreters and how and when to use a forensic linguist as expert. This experience has helped us to build multifaceted relationships with individual police forces and we have developed particularly good relationships with the GMP, the North Yorkshire Police and QinetiQ.

   CFL were instrumental in the Council for Registration of Forensic Practitioners accepting Forensic Linguistics as a sub-register and two members became Assessors before the organisation was forced to close due to the withdrawal of funding. CFL is now engaging with the Forensic Science Regulator over the plans to create a new Register of

accredited experts and with the Law Commission over the introduction of Daubert-type criteria for our expert evidence.

3. **Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?**

   At CFL we engage in police and intelligence work and this often draws directly on our research. Members of CFL have written numerous reports contributing to national and international legal actions in both civil and criminal cases. We have appeared at Crown Courts, High Courts and the Court of Appeal as well as at industrial tribunals, Coroners Inquiry's and Military Courts. In the Criminal sphere we have acted both for Prosecution and Defence. One good example of translation has been in cases involving the analysis of SMS text messages, which draws on work on the definition of the linguistic individual. In each case messages sent from mobiles phones appeared to provide some alibi to a defendant accused of murder by providing apparent evidence that the victim was able to text at a particular time and therefore presumably alive. In 2002 we acted as expert in the first murder trial to use the text messages as evidence and our analyses have contributed to both prosecutions for murder and to defence cases. One such case in 2009 (R v Hodgson) was appealed solely on the grounds of the novelty of the linguistic analysis; however, the Appeal Court judges accepted the evidence as valid and upheld the conviction.

   Forensic linguistics is considerably broader than comparative authorship analysis and some of our cases require social science expertise. One recent example is the determination of the meaning of items in an Internet Relay Chat which had been conducted in East London street slang. Linguistic analysis was required to decode some of the words and phrases used and to confirm that the interaction did indeed contain a conspiracy to murder. A second case involved work on the audio and written records of English/Polish interpreted tape recordings and interview data, where early on in the investigation poor translation of crucial passages had misled the investigators as to the details of a rape; disentangling the original evidence from its mistranslation involved the use of sophisticated state of the art computer-aided linguistic analysis.

   Whilst we are uniquely placed to translate our research into practice there are of course constraints. Because of the difficulty involved in determining population distributions of linguistic features, the statistical (Bayesian) presentation of results is problematic and this means that we currently have to restrict our judgements of authorship to measured stylistic consistency and distinctiveness and avoid opinions which claim to be able to uniquely attribute authorship. As noted above the issue of the best way to present the results of linguistic analysis is subject to much discussion and research in which we are actively participating.

4. **What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?**

   Forensic linguistics is clearly a small discipline, relatively new and comparatively unknown which crosses the boundaries between the sciences, the social sciences and the humanities. For these reasons obtaining funding through traditional academic channels can be challenging. It is significant that we have recently had more funding success with the intelligence communities than with more traditional academic and forensic ones.

5. **What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?**

   We are founding members of both the International Investigative Interviewing Research Group and the International Association of Forensic Linguists (IAFL) and have Board representation on both groups. In July 2011 we will host, for the third time, the IAFL biennial conference, at which we expect some 200 delegates.

   We participate strongly in less formal collaborations, including the exchange of staff on short attachments, particularly with Pompeu Fabra and Hofstra Universities, and are a destination for sabbatical attachments for research scholars from across the world, including recently China (3), Kurdistan, Spain (2) and the USA. On two occasions we have participated in 5-country bids for European funding, though so far without success.

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BARTS AND THE LONDON SCHOOL OF MEDICINE AND DENTISTRY

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

We are a small forensic unit working within a university department, undertaking forensic case work, conducting forensic research and teaching forensic science and forensic medicine at undergraduate and postgraduate levels. We have been involved in research in forensic medical science for over forty years but have seen our funded posts cut from six to one over the last ten years. Because of the current financial pressures on academia this single funded post cannot be seen as secure because we are not a large enough unit to be considered of core concern to the university.

We continue, nevertheless, to undertake and publish research, funding this and our staff with income from forensic-related service work in an ISO17025 accredited laboratory. We recognise that it is essential to maintain accreditation is essential, not only so that we can carry out our work, but also that we have a full understanding of the demands of forensic casework in the real world and can use this to inform our research. Accreditation does not come without resource implications and we are constantly frustrated not be able to give as much attention to research as we would like.

As a unit that is not core to the vision of the university we are not able to apply for internal research funds or opportunities for PhD studentships; nor, for the same reason, are students within the university able to apply for funds to undertake research in our research area. We constantly look for opportunities to apply for research funding but none of the Research Councils appears to offer opportunities in forensic biology. We have succeeded in obtaining research funding from the EU for two three-year periods, but opportunities to obtain EU funds are rare and the lack of continuous funding makes it impossible to maintain the momentum that such opportunities give us, even when they do arise.

Without further funding, our academic existence will continue to be under threat, and future research opportunities may be lost.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?**

We have no current partnerships. Previous partnerships with other forensic providers have been limited to one instance which was fully funded by ourselves out of our EU research fund.

3. **Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?**

Our research has enabled historical tests, that for technical reasons can no longer be repeated, to be translated into modern molecular procedures. This has enabled results from cold cases to be taken forward.

Our EU funded research looking at the use of single nucleotide polymorphisms (SNPs) has enabled the development of sets of SNPs which are used in phenotypic presentation for intelligence purposes. If it is going to be useful this type of research cannot be done on an ad hoc basis and needs continuous funding.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Universities are important places where research should be done, free from commercial interests. Research from academia is published and offered to the forensic community at large for others to develop to their commercial advantage if they wish. 'Black box' research, undertaken within a commercial environment, does not serve criminal justice if the methodology is not made available for peer review.

The chief barrier to research is the lack of funding in comparison with other areas of medical research, both nationally and internationally. It appears to be easier for forensic experts to be funded for research in areas where they have limited knowledge than in areas where they are already international leaders. Universities also seem much less likely to support small discrete areas of research which do not, apparently, fit with their core interests.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

The National Institute of Science and Technology (NIST) in the US is a very important organisation undertaking core research across the US but shared with others, internationally. Some countries, such as the Netherlands, appear to have more funds available for forensic research and scientists there are able, therefore, to be more productive. The European DNA Profiling group (EDNAP) is a group mostly consisting of academics in forensic science whose interest is in pursuing DNA research for criminal justice. The group is funded by the scientists themselves. This contrasts with the linked organisation, the European Network of Forensic Science Institutes (ENFSI), which will often take forward research into practice. Membership of the latter group is, however, limited to those who provide services to the police, so that some academics are excluded.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

No

UNIVERSITY OF BEDFORDSHIRE

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

The Division of Science currently runs a successful BSc Forensic Science degree supported by the recent appointment of Lecturer in Forensic Science. Our research interests currently focus on creating a profile of marker proteins to confirm the identity of body fluids found at scenes of crime. The underlying rationale is to develop more sensitive and specific analytical methods to positively identify the tissue source(s) present in a body fluid stain or tissue sample. Currently this is a limitation since some body fluids lack markers and several of those that exist have known drawbacks and raise the possibility of false positives. For example, in cases of alleged rape, there is not a definitive test to confirm the presence of epithelial cells within vaginal fluid from the victim. Furthermore, a test that would allow us to distinguish between circulatory or menstrual blood in a blood stain might provide pivotal evidence in a case

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Previous partnerships for this research had been fostered with LGC Forensics, Culham. This ended in 2010. With the closure of the forensic science service next year, links with their R&D department are now severely limited. The Division has close links with both the Beds and Northants forensic teams since staff deliver lectures and practical sessions to our undergraduate BSc Forensic Science students.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Body fluid analysis is becoming more and more critical to criminal cases. Methods have been developed to characterise minute traces of low copy number DNA (LCN) deposited in fluid samples that cannot be detected by the naked eye. Again sensitivity, specificity and reproducibility are key to securing a conviction.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

The current economic circumstances have led to research funding cuts across all disciplines; the possibility of adding to this research grant application is limited especially when there is not a specific research council or scheme dedicated to forensic science. The closures and cuts within the forensic sector show that there are not the opportunities for research within the commercial government forensic providers that

existed previously and also indicate that they would be unwilling to fund research at this time with those existing providers having an increasing casework load. This could be beneficial to the University of Bedfordshire with a gap in the forensic research market if external funding were available.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

The Forensic Science Society website provides a link to other researchers within the UK highlights a variety of forensic science conferences and seminars held throughout the year. They support an annual international meeting in the USA. Other international conferences cover a broader range of related subject areas such as the BIT life sciences annual world congress in forensic science and bi-annual seminars held by the California association of criminalists. More specifically, there is a UK based group focussed in the analysis of body fluids (The Body Fluids Forum). Their conferences are less frequent but also attract international delegates. Finally, companies such as Promega support an annual symposium focussing on human identification in the USA.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

No

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BIRKBECK COLLEGE, UNIVERSITY OF LONDON, WORK CARRIED OUT IN ITS DEPT OF BIOLOGICAL SCIENCES

1. What work relevant to forensic science is being done at your group/university and what are the opportunities for the future?

Our main area of expertise is in mycology and how an understanding of fungal biology can assist in the following:

Current research

Analysis of fungal species diversity and succession in the estimation of post mortem interval using animal (pig) analogues.

a. Analysis of fungal species diversity and succession in the estimation of post mortem intervals using material associated with murder victims (on blood spatter, food etc).
b. Deposition times of fungal spores (which may relate to post mortem interval) through direct field observation both inside and outside premises.
c. Taphonomic factors affecting fungal spores in palynological profiles.

Research opportunities

1. Experimental evaluation of the role of pollen, plant, and fungal spores and other plant and fungal remains in the provision of trace evidence for contact between objects, people, and places, and also in the search and location of clandestine burials and depositions. Much has been done experimentally on the nature of transfer from palyniferous surfaces to objects, fabrics etc., but these are highly theoretical and not based on case work. Our research is based on the needs of case work. Every case is unique, but we need to know the taphonomic factors affecting palynomorph acquisition by offenders from specific surfaces.

   The most valuable knowledge has been gleaned from case work but there are areas, highlighted by casework, that need investigation.

2. Estimation of minimum times of death through the sizes of fungal colonies developed on the skin and bones of cadavers, and also clothing and other materials associated with them.

   We have undertaken some preliminary experiments using pig skin analogues, and results which proved to be consistent with the actual facts have been obtained in a few criminal cases by Wiltshire & Hawksworth; there is, however, the possibility of devising standard protocols and experimental methodologies for use by investigating officers and their experts in post-mortem examinations.

3. Cause and time of death through the examination of plant/fungal and other food remains in the different parts of the gut.

   There is surprisingly little information, even in the dietary and medical literature, on the times different foodstuffs are retained in different parts of the gut during passage through it; hard data might be obtained through collaboration with pathologists undertaking autopsies where permissions for such examinations had been obtained.

   There are also, as far as we are aware, no guides illustrating, microscopically, plant and fungal materials at different stages of digestion. Experiments could be designed and undertaken to document the microscopic characters of harmful plants and fungi (including those that are prohibited drugs) at various stages of digestion as an aid to their recognition in post-mortem samples.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency etc.

Our current research collaboration is with Dr Patricia Wiltshire and Prof David Hawksworth CBE (also a Research Fellow at Birkbeck). These have been in actual cases where mycological expertise involving fungal growth has been required in relation to determining *post-mortem* intervals, and also in preliminary experiments undertaken as MSc projects designed or co-supervised by them.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Dr Wiltshire has been involved in over 200 criminal cases where palynological and/or other botanical and ecological evidence has been used as trace and contact evidence or in the location of clandestine burials or graves. The approach has therefore been extensively tested in court and is well-established, although there are few competent practitioners worldwide.

In several cases the ecological and palynological evidence has resulted in confessions, resulting in a considerable reduction in the costs of bringing criminals to justice. All cases where Dr Wiltshire has contributed critical evidence have resulted in conviction, apart from three cases of alleged rape where her data showed the suspect was innocent. On many occasions, palynology/mycology have provided the only forensic evidence.

The use of fungi in criminal investigations only started to any significant extent in the last few years. However, thirteen actual cases using fungi and

undertaken for UK police forces are mentioned in the review of Hawksworth & Wiltshire (2010):

[Hawksworth D.L. and Wiltshire P.E.J (2010) Forensic mycology: the use of fungi in criminal investigations, Science International. In press].

These have involved evidence of trace and contact, in some cases differentiating sites only 200 m apart, and also in ascertaining times of death.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

The opportunities are considerable, as noted in response to Q.1 above, but the topics are too hands-on and not sufficiently ground-breaking in a theoretical sense to be supported by the UK Research Councils.

In our experience, in a particular case a police force may fund a small research project to assist in its resolution, but nothing more. On occasions, the case has been such that Wiltshire & Hawksworth, in some cases with support from Birkbeck, have been able to carry out small, but important projects within the remit of the case. Results of such work can be published with permission from the investigating officers. Some of the types of basic studies we have noted that could be undertaken could perhaps have been supported by bodies such as the NPIA or the Forensic Science Service (before its commercialization and demise). The main barrier as we see it is a lack of a body with funds earmarked for research in forensic science that can support projects along a range from short-term (few months) to 3-5 years.

Much of our research could be carried out via relatively small projects to solve specific problems. These would need repetition, however, to verify results.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention.

There are no formal international organizations or professional bodies concerned primarily with our particular areas, although there are ones dealing with other aspects of palynology and mycology, and Dr Wiltshire and Professor Hawksworth have well-established and long-term informal contacts with individual specialists overseas.

We are aware of proposals to establish international working group under the International Union of Geological Sciences, but that will necessarily focus on the mineral compositions or rocks and soils although some of those involved would like to see the remit extended to cover biological sciences.

Dr Wiltshire (and possibly Professor Hawksworth) are collaborating with the Swiss Forensic Institute in Lausanne on casework. Again, much of the work will be experimental but not require large-scale funding.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

We are extremely concerned at the poor quality and irrelevance of much research carried out in UK universities and institutions which is labeled as "forensic".

Studies are often undertaken as student projects, are on a small scale, and have not been devised or supervised by staff with actual court-room forensic experience. This is particularly unfortunate as this means that public resources have often been used to fund work of dubious scientific value when more pertinent investigations could have been undertaken.

Sadly, many such inadequate studies do eventually get published in peer-reviewed journals which appears to give some credence to them. However, publication in a peer-reviewed journal should never be taken as evidence of scientific rigour *per se* as the system depends on the expertise of the peer reviewers of which there are few in the forensic botany/palynology/mycology field.

Much research in the environmental forensics is not directed at distinct forensic problems. They are usually highly theoretical topics where novel techniques (based on expensive equipment) are tested. Inevitably, because of the highly variable nature of environmental trace evidence and its taphonomy, such studies would never be acceptable because of the inherent variable nature of the environment, the mechanics of transfer, and the highly variable nature of offenders.

UNIVERSITY OF BRISTOL

1. Work relevant to Forensic Science and opportunities for the future:

Biological Sciences - *Forensic entomology* -– Richard Wall - Insects arrive at a corpse, lay eggs and their larvae develop, at a relatively predictable rate. Hence, correct identification of the insect larvae present and an understanding their development and oviposition behaviour, forms the basis upon which estimates of the post-mortem interval can be made. The insect species present may also provide a wealth of information about factors such as geographical location, burning, burial, movement of a corpse, drug use or the presence of gunpowder residues. The Wall group undertakes research in this and a range of related fields [references available].

Chemistry – *Industrial Forensic Science* is being developed in close collaboration with industrial companies. Work is being carried out on the development of a range of analytical techniques to detect prohibited mixing or copying of industrial commodities such as vegetable oils, animal fats and pharmaceutical products. Improvements in the monitoring of soil and natural water pollutants are currently being sought by the development of new methods of analysis for detergents and toxic metals.

Chemistry - Richard Evershed - Applying the principles, techniques, and rigor of organic and analytical chemistry, to tackle questions in the fields of: (i) archaeological chemistry, (ii) biogeochemistry, and (iii) biomolecular palaeonotology. All three fields are inextricably linked by interests in the preservation, recycling, decay and transport processes, impacting on biological materials when they enter the geosphere.

Archaeology and Anthropology *Bristol Osteoarchaeological Research Group* (BORG) – Kate Robson – Green- BORG provides osteoarchaeological services to a range of sectors including archaeological contractors and forensic services http://www.bris.ac.uk/archanth/staff/robson-brown

Engineering - *Cryptography Group* - Theo Tryfona - network security & forensics- developing advanced forensic tools against Internet abuse, network security & forensics, develop novel ways for law enforcement to enhance their practice of network forensic analysis and response (ISEC action grant of over 600,000 EU). Plans for the future (not currently funded to progress) may include the combination of intrusion detection by appearance with intension specification languages (ISL). Work on ISLs in security seem to have died down since the late 90s, but they could provide some useful formalities for using intrusion detection techniques with a variety of sources, not just data packets over a network (e.g. CCTV streams, which would then make it a very relevant forensic-type work). Reverse engineering for system verification purposes could be of particular interest for the defence & security sector - e.g.

particularly after incidents of concern like a helicopter crash, is it possible to detect whether a third party component that was manufactured or assembled in a foreign country exhibited no unaccounted behavior.

Elisabeth Oswald - SILENT-Side-channel analysis: Theory and Implications for Society - Side channels silently leak information about confidential data (e.g. cryptographic keys, user data etc.) and are hence a serious threat to the trustworthiness of information systems. For example, power consumption traces of cryptographic device (e.g. a bank card, mobile phone, PDA) often show patterns of different length and shape. Each pattern corresponds to a particular low-level instruction (e.g. SETB, RET) of the device's instruction set. Reconstructing the instruction sequence can allow an adversary to reconstruct the program executed by the device, and more devastatingly, might give away information about the otherwise secret cryptographic key. With respect to forensics, side channels can be used constructively: by embedding e.g. a hardware Trojan circuit into a chip, and by later on analysing the side channel signature of this chip, one can check whether a chip is genuine or not.

Computer Science - Walterio Mayol-Cuevas, Andrew Calway- **Augmented Crime Scenes:** Virtual Annotation of Physical Environments for Forensic Investigation. This work is peripheral to forensics but may be an enabling technology. They have developed a system for wide area mobile augmented reality which enables teams of users to 'tag' physical structure with virtual content and then allows other users to view that content in situ. This is useful in applications in which there is a requirement to quickly gain an understanding of a previously unseen environment, such as a building, and to tag areas or objects of interest. One such application is in forensic science, in which logging evidence in its physical context is important for subsequent visualisation and for indicating areas of interest or concern for later detailed analysis.

Statistics (School of Mathematics) - Peter Green has been developing methodology based on Bayesian Networks for assessing the sensitivity of inferences based on DNA profiling to departures from standard assumptions, including the impact of population heterogeneity, uncertainty in allelic frequencies, and identity by descent and other kinship problems. Cases considered in published work to date include criminal identification, DNA mixtures, and simple and complex disputed paternity cases. This is being extended to deal with refinements such as peak-area estimation, and artefacts such as stutter and drop-out.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Richard Wall (Biological Sciences) has provided forensic entomology expert witness services to a number of solicitors in legal proceedings.

Members of Archeology provide forensic advice to regional police forces on discovered skeletal remains.

Michael Naughton (Law) has worked with Avon and Somerset Constabulary on retention policies of forensic science providers

Theo Tryfona (Cryptography Group) has collaborated in the past in research and knowledge transfer programmes with the Metropolitan Police, BT, local Trading Standards, Avon & Somerset Police etc. His current research on network forensics will include work with Europol, whose R&D he will complement with this grant, and potentially the Laboratory of Cyber Defence of the Greek Army, who have offered to participate in end-user testing of any implementation.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Richard Wall's group were among the first to pioneer the use of genetic information to aid in the correct identification of insects of forensic importance, but have been unable to interest anyone in funding further research or adopting this approach.

The net forensics grant (ForToo) is intended to be translational- the final outcome will hopefully include open source software tools to be used by police forces across the EU to analyse network intrusions and e-crime.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

There appears to be no publically-available funding for forensic research. In addition the reluctance, for obvious reasons, of particularly corporate victims to discuss incidents, let alone provide information and support public/open research, could be an issue.

The growing necessity to incorporate digital forms of evidence as part of conventional investigations (e.g. examining a victim's emails, text messages etc.), as well as the computer-intensive nature of some activities of organised crime (e.g.on-line rings of paedophiles), have created some awareness of the need for study and R&D in digital forensics. If the Government is willing to facilitate a targeted approach of players in the private sector who may have significant interest in mitigating costs of e-crime, that could enable the creation of public/private partnerships to sponsor relevant research (e.g. Serious & Organised Crime Agency, bookmakers etc.)

5 What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

Digital forensics is quite a niche academic and industry 'market' and as such large networks of support do not really exist. Smaller conferences and fora play a role at the minute and they often get dominated by marketing of specific tools which potentially diverts from the real needs for research & development.

No others.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

None were raised.

Addendum
The Centre for Chemometrics
http://www.chm.bris.ac.uk/org/chemometrics/research/research.html) - was closed recently, Richard Brereton is continuing the work as an independent consultant and will be submitting a separate response.

BRUNEL UNIVERSITY

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

Recent work at Brunel in this area has focused on the application of surface science techniques to forensic science, including substantial work in the analysis of fingerprints. Particular research programmes include the investigation of the interaction of development agent with both the fingerprint and the surface, enhancing fingerprints in blood and the influence of nanoscale design of powders on the efficacy of print development.

We have also led a programme of research on DNA receptors with nanotags on cartridges, arising from an EPSRC Ideas Sandpit, aimed at developing a new nanotechnology relevant to gun crime control. The research team, which consisted of a number of university and industrial partners, was able to increase the amount of surviving and recoverable DNA on cartridges using DNA traps, and tag illegal gun users

Brunel is also engaging in a wide range of research activity where the link to forensic science may not be immediately apparent, but where the outcomes may influence the forensic science of the future. This includes a portfolio of research programmes in basic physical and engineering sciences, materials engineering, nano-technology and biology. For example, recent work in our Experimental Techniques Centre on the forensic analysis of fire-damaged mobile phones utilized a technique from space science, which does not have immediately obvious relevance to forensics.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?**

Bunel has been working with the Home Office Scientific Development Branch (HOSDB) on the fingerprint project since 2006, both as funders and collaborators. We have worked more recently with a number of police force laboratories, including the Metropolitan Police. In the past we have worked with the Forensic Science Service both as a project sponsor and a partner in an EPSRC CASE award.

The DNA receptors project also included the Forensic Science Service as a key project partner, and this project also had a link to Sussex Police, through a criminologist based at Brighton University, who was an academic partner on the project.

3. **Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?**

Brunel's close ties with the HOSDB have allowed enhanced interaction with the end-users of forensic science research. This has enabled the transfer of new ideas and research results to practitioners, both verbally and through

contributions to Home Office guidelines. This also enables researchers to understand the operational realities of the forensic science community, enabling prioritisation of research and timely assessment of problem areas.

The DNA receptor project was featured by the EPSRC in one of their impact campaigns, but the translation of DNA traps into practice is difficult, largely because although the costs of the changes to cartridges would be small, the benefits are a "public good" and would not flow directly back to cartridge manufacturers. Innovations of this type probably need legislation to drive them into practice.

4. **What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?**

The cross-disciplinary nature of research in this area can present a hurdle to finding funding. For instance, fingerprint research draws on physics, chemistry and biology as well as forensic science, and this can be problematic when calls from funders focus on a particular discipline. Forensic science is an important element of the Global Uncertainties theme identified by the Research Councils as a cross-Council priority.

5. **What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?**

Brunel has no existing international partnerships in this field. However, we are developing a UK based collaboration on novel fingerprint analysis with researchers at institutions including the National Physical Laboratory, the University of Surrey and Imperial College. We aim to position this collaboration as a hub for new international research collaborations.

6. **Are there any other issues relevant to our terms of reference that you would wish to comment on?**

The closure of the Forensic Science Service (FSS) will be a significant challenge to the UK's research capability in this field. The FSS, in addition to its role as service provider, is uniquely positioned to conduct its own research, and is experienced in working in collaboration with other bodies such as universities.

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THE INSTITUTE OF PUBLIC HEALTH, UNIVERSITY OF CAMBRIDGE

1. **What research do you fund relevant to forensic science?**

   Work undertaken: on the demography and toxicology jointly of drugs-related deaths, which requires better-standardized toxicology and prompt registration (such as within 8 days, as in Scotland) of the fact of death because registrations which are delayed until coroner's verdict handicap the proper monitoring of emergent risks - be they illegal-drug-related deaths or deaths from pandemic influenza.

2. **Do you have any mechanisms specifically to support forensic science research?**

   Research links with National Police Improvement Agency: as peer reviewer and independent commentator, for example on statistical analyses of, and data held on, National DNA Database.

3. **Do you have any mechanism for identifying any potential forensic spin off from the broad range of funded research projects? Should there be such mechanisms?**

   Research translation: opiate/cocaine test in saliva is able to detect recent use in about 8 out of 10 persons which is 'sufficient' for police purposes but could have public health surveillance applications if further improved.

   It is not clear whether forensic science practitioners have set up quality assurance schemes (such as other laboratories have) that encompass how thoroughly Scene-of-Crime-Officers (SOCO) go about their business. Whilst we appreciate that the design/set-up of quality assurance schemes which involve SOCOs is more difficult than the sending of blood for analysis to multiple tissue-typing or immunology laboratories, we feel that inter-force comparisons should be made, as well as comparison of forensic-providers.

4. **Are you aware of any real or perceived barriers to the funding of forensic science research and are there ways that could be explored to overcome these?**

   Barriers to research funding: both commercialization of forensic science provision and budgetary-limitation by police forces on a) choice of crime-scenes to which SOCOs are sent, and b) time-spent if sent are potential barriers to research for public good. Research funding is best directed where there is likely to be substantial pay-off, not limited application. Detection rates by police, other than for some of the most serious crimes such as homicide, are surprisingly low and they suggest insufficient application of science, which includes statistical science as applied to evidence synthesis.

5. Are there any other issues relevant to our terms of reference that you would wish to comment on?

International networks: We have no specific knowledge, other than to remark that UK should heed international scientific literature pertaining to aspects of forensic science, especially on poor performance of so-called technologies such as for lie-detection.

Maximal use should be made of formal randomized experiments and, where possible, blinding and inter/intra-observer variation in the assessment of new and existing technologies.

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UNIVERSITY OF CANBERRA

Submission to Review of Research and Development Relevant to Forensic Science

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future ?**

The University of Canberra (UC) has been involved with forensic science education since the early 1990' with an undergraduate degree program, more recent involvement in online postgraduate qualifications and an active Research program. Our R&D takes place through Honours, Masters and Doctoral programs and on occasion at the Post Doctoral level. We have a broad interest across the forensic sciences with specific focus on environmental forensic science, wildlife forensic science, biosecurity, fingerprint research, forensic biology (including DNA), forensic toxicology and trace evidence. Our group has an excellent record of publication . We work cooperatively with colleagues in our own university (for example the Institute of Allied Ecology)and with other universities to establish research strengths through virtual teams and have an especially strong link to the University of Technology, Sydney. The opportunities for the future are only limited by two things, one's imagination and the ability to win funding support !

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Agency etc?**

The framework for forensic sciences in Australia includes our National Institute of Forensic Sciences (NIFS) who are a part of the Australian and New Zealand Policing Advisory Agency (ANZPAA) - broadly similar to NPIA in the UK but on a smaller scale. Part of the mandate for NIFS is to coordinate activities such as forensic R&D. They have very limited funds to actually pay for research but have achieved significant influence by supporting the industry and academia to come together and by developing a strategic vision and identifying R&D priorities. Forensic Educators in Australia and New Zealand have a formal group who are included in NIFS activities. The other key group is our Senior Managers Australian and New Zealand Forensic Laboratories (SMANZFL). This group and NIFS work closely together to represent all of the forensic sciences including crime scene and other field activities – this is a particular strength of our system.
Prior to moving to my current position mid last year I had been the Senior Executive and head of the Forensic and Data Centres group with the Australian Federal Police (AFP) since 1989. I had a specific R&D budget which was used to support internal and external research.We had a position of Chief Scientist an, R&D committee and a five year R&D plan.Our approach was to leverage our " money " (in the order of $500,000 per year) to work with academic partners to win competitive R&D funds within the Australian Research Council schemes. One especially useful scheme in Australia is the industry linked (Linkage) scheme where the industry has to commit actual cash as well as in kind support. This meant that the R&D was to an

appropriate level driven by the industry with more practical aims and outcomes. The AFP was a very active partner in many successful Linkage grants.

Finally, the Australian Federal government have supported significant R&D in the security space with much of that work being carried out cooperatively between industry and academia. A rule for this funding was that 50 % of the funding had to come from industry.

3. **Can you give good examples in the forensic science field of translation of research in to practice, and also examples where this has been difficult of problematic ?**

There are many good examples in Australian of R&D transfer including examples in areas such as fingerprint enhancement techniques, DNA analysis, drug profiling etc. Often R&D will give answers which are directly relevant to actual cases and evidence interpretation. However, R&D should not be seen simply as technology transfer nor should the immediate translation of R&D been seen as the only measure of success. Even at an industry level it is important that " the industry " (not individual players) keep an appropriate balance of short term and longer term research. It was Pasteur who said that there is no such thing as applied research only the application of science.

However, sometimes the bridge between publishable research and application cannot be immediately bridged. A good example of this is Raman Spectroscopy where it is only in recent years that the technical problems with this science have been largely overcome. Another example was work done in the early 1980's in the then Metropolitan Police Forensic Laboratory on High Performance Liquid Chromatography (HPLC) for fibre dyes. This work was published but the technique was abandoned because in practice it was simply not robust enough for case work application.

I understand that this review will not include looking at the commercial market BUT it is critical that it is clearly understood that commercial R&D has different rules to public R&D.

However, private sector R&D relies heavily on the longer term on more blue sky R&D often conducted in the public sector.

4. **What do you see as the opportunities for , and the barriers to, the funding of research relevant to forensic science?**

The barriers to funding are numerous. They start with the fact that Research Councils around the world simply do not classify forensic science as a stand alone discipline. Hence forensic researchers are competing for limited funds against researchers who do not recognize the discipline. For some research this is not a problem but for more applied (application orientated !) research it most definitely is a problem. A second problem has been, and remains, the

ability of the industry to fund or support research. In part the latter reflects the industry which is very practical and often simply does not understand R&D. Prior to my moving to Australia I was an academic at the University of Strathclyde who have the oldest degree program in the UK. I can certainly recall how difficult it was to win funds for forensic research. At least part of the problem in the UK is the emergence of the plethora of academic institutions offering forensic programs. Without wishing to comment on the overall quality of some of these programs , given the number and looking at the academic literature , there is remarkably few publications which I assume reflects litter research taking place. Critical mass is important in research however that is achieved.

5. **What are the important international networks and how useful are they ? Do you have any specific international collaborations you would wish to comment on ?**

There are a number of international manager level groups such as our SMANZFL, ASCLD in north America and ENZFI in Europe. All have strategic views of R&D , all call for more R&D and all have specialist science groups who develop ideas around priorities etc. However, essentially none have serious R&D money! That is not to say they do not have a serious role to play as there is little point in reinventing the wheel and there are areas where global cooperation is possible and important.

The work of ENZFI recently on DNA has been useful beyond Europe. In one of my areas of interest, fibre examination , there has been very good cooperation between the various specialist groups around the world. At an academic level cooperation tends to be limited to bilateral or slightly larger collaborations. International cooperation is often limited by funding with issues about sharing funds overseas and funding to even bring people together. In this regard the EEU has several schemes that have not been well accessed by the forensic community outside of Europe but some very useful cooperative R&D has been funded inside Europe. A good example of this is in the area of illicit drug analysis with the work to harmonize methods.

In my own university we have well established links with several universities overseas. Our strongest relationship is with the University of Lausanne.

6. **Are there any other issues relevant to our terms of reference that you would wish to make comment ?**

Bye way of a more personal comment on the situation in the UK , as I stated above I started in forensic science as an academic in the mid 1980's at Strathclyde. At that time the Home Office forensic service had its well respected Central Research Laboratory (CRE). I would not wish to downplay the important role this group played in the development of forensic science . However, from the perspective of an academic we had ,at best,a frustrating relationship with CRE. To put this simply, if we had what we thought was a good idea for research and raised this with CRE for discussion, the conversation would most often follow the lines of " if this is such a good idea

we would have already thought of it " ! Or, " we already tried that and it did not work " ! There was also a reluctance to fund anything outside of CRE and I can recall one Director of CRE specifically saying that if he were to fund research it would not be a forensic group as he wanted " real science ". As the UK Government funded CRE the view was that forensic science was in good hands and taken care of.

As an observer of developments in the UK since leaving some 27 years ago , and notwithstanding my frustration in dealing with CRE at the time, I have viewed with increasing dismay the path followed by CRE and its successors by whatever name. In the most recent era they have almost ceased to publish openly and have been patent and product driven. This is fine if you are a private organization developing products to sell. This goes to the heart of the matter. Is forensic science an industry out to make a profit and conducting R&D to develop a commercial product to sell , or , is forensic science a service provider, conducting R&D to improve its services through innovation ? These are quite different paradigms with different rules.

Whichever way the UK decides to go in the future there is one thing that is certain, if you do not develop an open system which encourages industry involvement with academia and others in the UK, Europe and globally, then you will not capture innovation for the future. Unless the industry both understands R&D and has the resources to be an active player then the R&D will be a poor match for what industry requires.

James Robertson AM PSM
Professorial Fellow
Director NCFS

CANTERBURY CHRIST CHURCH UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Forensic Computing

1. Paul Stephens (Senior Lecturer Department of Computing) is currently in the final stages of work towards his PhD in Developing Models for Cybercrime Education for Law Enforcement.

2. Denis Edgar-Nevill (Head, Department of Computing) is leading a British Computer Society Cybercrime Forensics Specialist Group development with the 2Centre European Union funded project (led by UCD - Ireland and University of Troyes - France) to develop a framework of centres of excellence in Forensic Computing in the UK. This currently divides the UK into seven regional groupings involving more than 200 UK universities, regional police forces and commercial organisations. This network is part of a larger EU wide network to establish benchmarks for good practice and share teaching and research resources across the network.

3. Department of Computing has engaged in a number of Forensic Computing projects involving MSc dissertations. Examples in the last two years include of Redefining the Copine scale, Support for Police Viewing Indecent Images in High Tech Crime Units, Detecting Police Corruption Involving Computer Data, Mobile Phone Forensics Standards.

4. Department of Computing hosts an annual International Conference on Cybercrime Forensics Education and Training (CFET) since 2007 which has attracted speakers from 18 countries around the World. Keynote speakers have included Ed Gibson – Microsoft UK, Steve Edwards MBE – eBay UK & Professor Xu – Beijing Olympics Website Security (CFET 2008), James Brokenshire MP – Shadow Home Affairs Minister (CFET 2009) and Andrew Rennison UK Forensic Regulator (CFET 2010).

5. There is a need to establish benchmark standards for education in the UK which would be greatly facilitated by formalising local links between regional police forces and local universities. This would facilitate regular consultation on developments in this fast moving area and provide a more uniform consideration of ideas and new services nationally.

6. The Department of Computing has had a stand at the ACPO National e-Crime Conference at Wyboston for the last four years.

Law and Criminal Justice Studies

1. Robin Bryant is a Special Advisor to the Board of the European Cybercrime Training and Education (ECTEG) group convened and hosted by Europol. ECTEG is responsible for implementing a European-wide programme of training in forensic computing investigation.

2. The Department has been involved (in training design and accreditation) between 2009-2011 in an ISEC funding European initiative in mobile phone forensics, Windows 7 forensics and database forensics.

3. Edmund Day (lecturer in the Department) is currently engaged on a research-based PhD into the application of Grid Computing to the Automation of Mobile Phone Forensic Investigations.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Forensic Computing

1. NPIA – Since 2003 the Department of Computing has been working with the NPIA (and its earlier form CENTREX) High Tech Crime Training Unit jointly validating the MSc in Cybercrime Forensics with the NPIA in 2005; revalidating the MSc at its review in 2010. This is a closed course for police, Home Office etc and has involved registering students from across UK police forces. The research component has been developed through masters dissertations and publications at the CFET international conferences hosted by the Department.

2. ACPO/PeCU - Denis Edgar-Nevill (Head, Department of Computing) is a member of the ACPO Editorial Panel currently revising National Standards for Digital Evidence.

3. Justice Institute of British Columbia, Canada – exchange visits of research staff and the head of the institute is a member of the International Advisory Panel for the CFET conferences.

4. Vancouver Police Department, Canada – exchange visits of research staff.

5. Royal Canadian Mounted Police, Canada – exchange visits of research staff.

6. Overseas Universities – exchange research visits with University of Colombo – Sri Lanka, University of Mauritius, Champlain College – USA, Macquarie University – Australia.

Department of Law and Criminal Justice Studies

1. Members of the Department contribute to the training of Crime Scene Investigators for Kent Police.

2. Robin Bryant (fatal falls from height) and Kevin Lawton-Barrett (forensic investigation) are advisers to police forces and expert witnesses.

3. Robin Bryant assesses Estonian police training (including CSI training) for the Estonian Ministry of Education.

4. Shauna McCusker has been a member of the Board of the Forensic Science Society.

5. The Department is currently discussing joint research with the Kent Fire and Emergency Service.

6. Partnership with An Garda Siochana (the Irish national police) in the development of on-line training materials for forensic computing investigators.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Forensic Computing

1. Standards developed as a result of MSc Dissertation Support for Police Viewing Indecent Images in High Tech Crime Units has documented developments by East Sussex Police have helped inform the ACPO revision of national standards for Digital Evidence.

Law and Criminal Justice Studies

1. Application of mathematical understanding of cryptography and steganography to a joint programme (subject to successful bidding) with the German national police on criminal use of 'anti-forensics'.

2. Research informed our publication 'Investigating Digital Crime' published by John Wiley and Son. It is also informing our forthcoming book 'Policing Digital Crime' to be published by Ashgate publishing in 2011/12.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Forensic Computing

Opportunities - Recent announcements by the UK Government for additional funding of developments to fight cybercrime may mean resources are available to fund research developments in this area.

Law and Criminal Justice Studies

EC funding streams (notably FP7, ISEC and LdV) remain flexible enough to permit innovative and pan-European bids for funding to support research – important in an area such as cybercrime forensics. The barrier is that 'forensic science' is a misunderstood subject area in the UK and is not (we would

argue) synonymous with 'forensic investigation'. There is a dynamic interplay between science (including scientific techniques and technological applications), law enforcement (primarily criminal investigation conducted by the police) and the demands of the criminal justice system, which together are the defining features of modern forensic investigation. This interplay is not reflected in, for example, the new Research Excellence Framework.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

Forensic Computing

1. British Computer Society Cybercrime Forensics Specialist Group – Was established by Denis Edgar-Nevill and Professor Margaret Ross in December 2008. It now has developed to the point where it has 1300 members in 44 countries. Denis Edgar-Nevill – Chair, Dr Abhaya Induruwa – Treasurer, Paul Stephens – Membership Secretary, represent the Department on the SG committee made up of academics and professionals across the UK.

2. 2Centre European Union funded project - (led by UCD - Ireland and University of Troyes - France) as it develops will establish an important international grouping for research and development.

Law and Criminal Justice Studies

1. The Department is represented as an Associate Member at ECTEG (see our response to part 1. above) and Special Advisor to the Board. ECTEG's membership includes representation from all European police cybercrime investigation units, Europol, Interpol, the NPIA, OLAF, the OSCE, the UNODC, Microsoft, Google, Ebay and Visa. ECTEG is of major importance in terms of the co-ordination of a Europe-wide response to cybercrime as recognised in a recent Council of Europe report.

2. Robin Bryant is a member of Program Committee for the conference 'Criminalistics/Criminal Investigation in Europe: State of the Art and Challenges for the Future', September 22/23 2011, University of Maribor, Slovenia. ('Criminalistics' in this context is a reference to forensic science).

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

CARDIFF UNIVERSITY

Response to 'Forensic Science Research and Development'

We welcome the opportunity to comment on the review of research and development relevant to Forensic Science. The following comments were made by some of the researchers here at Cardiff University.

General Comments

While we recognise that the review does not include forensic pathology and medicine, Cardiff University has a large number of academics working across several schools in these areas such as forensic pathology, engineering, psychiatry and psychology. As such our response is not as comprehensive as we would have hoped and has been limited to input from only a small pocket of researchers.

Response to Questions for Researchers

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Cardiff is currently conducting a program of research funded by the Medical Research Council, relating to bruises in children, including exploration of DNA techniques, and novel imaging processes to delineate bruises more clearly and possibly demonstrate bruises that are no longer visible to the naked eye. All of this work relates to bruising as a common feature of child abuse, and informing the distinction between an accidental and an inflicted bruise.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

The Cardiff child protection research group currently has research partnerships with the Forensic Pathology service in Leicester, the Forensic Odontology at Glamorgan University, the National Policing Improvement Agency, the Home Office Scientific Development Branch, and the University currently sits on the Universities Police Science Institute Management Committee.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

In the area of Child Protection, on the main areas within Cardiff University, there has been a high level of high quality basic science work. The one area where there has been translational work is in the field of Forensic Odontology, where improving scientific techniques may enable more accurate identification of the perpetrator of bites on children.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

One of the main barriers to the funding of research is the multidisciplinary nature of the work being undertaken and national forensic funding bodies not collaborating in order to fund these important areas.
On a more positive note, there is now an excellent nationally co-ordinated multi site ethical application process, enabling the type of multicentre research study that this field needs.
However, funders have to pay for the full research team to be in place for up to one year before a single research study case can be recruited, simply to satisfy the multiple local R&D arrangements present in a multicentre research study.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

With respect to some of the academics here at Cardiff in the area of Child Protection, they are part of an international Child Protection Specialists Network called the Ray Helfer Society. In addition a number of past academics have been members of The Forensic Science Society.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?
   No additional comments.

Cardiff University 21th March 2011

CRANFIELD UNIVERSITY
CRANFIELD FORENSIC INSTITUTE

The Forensic Institute of Cranfield University is a research led, wholly postgraduate unit specialising in niche areas such as forensic engineering (firearms and explosives) anthropology/archaeology and computing. As such the Institute has a diverse range of forensic activities through education (CPD, MSc's and PhD's), casework and translational research programmes.

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Cranfield Forensic Institute focuses its efforts on niche themes within forensic science, rather than seeking to adopt a generalist, teaching-led research strategy. Often casework is concerned with difficult forensic cases, rather than bulk processing, and has included cases involving terrorism, organised crime, and a corrupt police forensic investigator. Specific areas of expertise include forensic archaeological practise, ballistics and explosives, forensic materials analysis anthropology/bone biomechanics and forensic computing.

Examples of current relevant research programmes include:

- Navigation/psychological research undertaken to inform on likely routes taken by offenders engaged in clandestine burial.
- New DNA triage analysis systems.
- Examination of best practice in attempting to record tool marks in soils from clandestine graves.
- Physico-chemical methods of assessing bone to provide time since death and species specific information.
- Adaptation of archaeological excavation techniques for use on the forensic fire scene.
- Analytical miniaturisation for drugs and explosives assessment.

Much of these focus on scene-based disciplines and translational research, which have traditionally enjoyed a lower profile within academic research when compared with 'purer', laboratory-based disciplines.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Cranfield Forensic Institute has enjoyed a close working relationship with LGC and is currently developing links with Manlove Forensics. Staff members have ties with numerous policing agencies, both in the UK and internationally. One member of staff remains an NPIA-registered expert in the field of archaeology, and has participated in NPIA-led case conferences as an external advisor. The CFI will be the host for the forthcoming Forensic Ecology Training Course run by LGC Forensics and offered to UK CSIs. We have strong relationships to the MOD through, for example, sponsorship of research projects and hosting of RMP forensic training courses.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Cranfield University's mission is underpinned by a strong philosophy of translating research from the laboratory into real world application. Staff members ensure not only that their experiences feed directly into their teaching and research, but also that their research produces data or products that are of direct use to the professional forensic practitioners. Recent examples include:

- Attempting to assess the optimum means of recovering tool marks from grave soils.
- A new method for rapid and reliable drug and explosive detection that is currently in development with a VC company.
- A forthcoming project that aims to use GIS-based analysis to revisit the disappearance of April Fabb in 1967 (this in conjunction with Norfolk Police).
- A novel system for species identification from burned bone fragments (currently in assessment by LGC Forensics).
- Forensic computing has it has included techniques to identify covert encryption (duress keys) and the recovery of deleted search indexes from Microsoft Windows, both of which have now been tooled and are available to the law enforcement community.
- Research into Live Forensics dealing with encryption and memory analysis has affected the interpretation of the ACPO guidelines, resulting in more emphasis on principle 2.

Translation of research is facilitated by having operationally-active members of staff. Where such a close link does not exist, it is difficult to bridge the gap between operational problems and scientific solutions.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

A primary barrier to funding for relevant forensic research is the failure of any one Research Council to take responsibility for this valuable applied research. As an example, forensic archaeology might span between EPSRC with regard to response of materials, decay studies or geophysics; to NERC for more standard archaeological approaches; through to AHRC for the interpretative arm of the discipline, which might still be in a position to offer important insights. None of the abovementioned Councils are happy to take responsibility for the field of forensics research which appears to be currently 'homeless'.

There is also a notable lack of real 'drivers' for championing forensic science research with the majority of recent translational work narrowly focussed on DNA. The drivers that do exist are disengaged from potential fund providers. One may argue that there appears to be significant re-invention and little true innovation. 'Research' is dominated by short-term problem solving frequently funded through casework. Whilst such casework may stimulate questions for

longer term study, there is little funding to support this i.e. research tends not to be 'front loaded' as is the case for more traditional areas.

The lack of a unit of assessment for forensic science in the REF somewhat undermines any bespoke research activities. A possible opportunity may be the establishment of doctoral centres with appropriate end-user collaboration, to support forensic science strategically within the U.K.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

The importance of forensics research, development and dissemination is global. Cranfield Forensic Institute encourages its team to join the Forensic Science Society which is an international professional body with members in over 60 countries, and utilises strong links to the US via the AAFS and also maintains an associate membership of ENFSI. We work on the international stage through our strong relationship with the charity 'Inforce', who have developed and maintained projects in Cyprus, Columbia, Iraq and Rwanda. We have also been requested to tender for delivery of a Crime Scene Investigation training course to the Indonesian National Police and have technological collaborations with forensic institutes and industries within Europe. We are involved with the U.S. Scientific Working Groups and such a model of providing research support to forensic science is worthy of further consideration.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

A number of fault lines exist within UK forensic science research that obstruct the easy passage of research-based innovation from universities to application on the crime scene including:

- Development of academic forensic science has generally focussed on teaching establishments, producing a relatively narrow base of research when compared with the staff involved in delivery (Cranfield Forensic Institute is somewhat different to the national model in this regard).
- Academic researchers frequently lack an understanding of crime scene operational requirements and needs as very few have enjoyed first-hand experience of forensic practice (again, CFI is somewhat luckier than many universities).
- Private sector forensic service providers have tended to be nervous of developing close relationships with research-based departments, due to the novelty of the markets in which they are engaged.
- Crime Scene Investigators in the UK have generally regarded themselves as a skilled trade, rather than as a profession - as such, they have no developed tradition of continuing professional development or engagement beyond that provided by their employing forces on a mandatory basis.
- With the demise of the Forensic Science Service, an increasing amount of taxpayer's money will be directed towards the private sector.

Therefore it would seem appropriate that an increased responsibility of the private sector to support forensic research should be encouraged and stimulated by government.

DE MONTFORT UNIVERSITY RESPONSE TO THE HOME OFFICE REVIEW OF RESEARCH AND DEVELOPMENT IN FORENSIC SCIENCE

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

- Dried blood spot (DBS) analysis – targets any drug named therapeutic or abusive.
- Analytical methods for target residues based on LC-MSMS and GC-MSMS systems.
- Identification of counterfeit drugs – use of SEM/EDX or LC-MSMS systems
- Stand-off detection technologies for radiological threats. NATO special studies group. NIAG SG112
- Novel methods for closed circuit assessment of residual radiation.
- Aging of dry blood spots using atomic force microscopy.
- Identification and removal of contaminants such as toxic chemicals from water by a mobile decontamination unit in case of a malicious dosing incident of our water reservoirs.
- Pollen or soil on clothing as a Forensic tool
- Fingerprint and impression evidence visualisation and recovery – recovery from difficult surfaces and novel methods of recovery.
- Authentication of medicinal herbs and herbal medicines using DNA based technologies
- DNA methodology for identification of soil and human remains
- Software enhancement of tool marks

Further details of some of these projects can be found at http://www.dmu.ac.uk/faculties/hls/pharmacy/forensic/research.jsp

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

De Montfort University has a long established and close working relationship with the Leicestershire Constabulary. We have some indirect links with other constabularies, the NPIA and industry.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

There is a general view that taking forward in to practice the results of research can be a difficult procedure even when that research is funded by outside agencies and addresses identified needs as exemplified by experience with the Identification and removal of contaminants such as toxic chemicals from water project. However, several of our research projects developed in close collaboration with end-users should shortly be in a position to be translated in to practice. This close collaboration between end users with a clearly identified need and the research team is key in ensuring a high probability of the research being converted in to practice.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Opportunities for funding clearly do exist in some areas that coincide with current government priorities and funding for "near-market" research is available in specific cases from end users. However, there are limited opportunities for funding of research related to forensic science as much of the work sits outside the core remit of many of the "usual" bodies funding research despite historically there being some schemes specifically aimed at funding forensic science research.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

A variety of International Networks such as the Scientific Working Groups and various practitioner/professional body networks are key in disseminating current practice and indentifying key areas for investigation. Networks in general are vital in bringing together end users, providers and researchers in a meaningful fashion so as to maximise the benefits from and likelihood of application of research.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

No

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UNIVERSITY OF EAST ANGLIA

1. **Forensic Science at the University of East Anglia (UEA)**

There is considerable research work being performed in the Forensic sciences at UEA. Specifically; **Professor David Russell** (Chemistry) has been funded by the EPSRC research council to develop colorimetric bioassays based on gold nanoparticles for the detection of biological agents used in bioterrorism. This work was jointly funded by the EPSRC and by the DSTL (MoD) through the joint grants scheme.

A second project funded by the EPSRC was to develop a novel technology for the detection of drugs and drug metabolites in fingerprints. This project involved a number of governmental and forensic organisations, viz, Home Office Scientific Development Branch; Forensic Explosives Laboratory (DSTL); Forensic Science Service (FSS) and a forensic provider Forster and Freeman.

The research was continued with an EPSRC follow-on grant and ultimately this work has led to a University Spin-out company 'Intelligent Fingerprinting Ltd'.
Both projects are ongoing and have further potential for the future.
A new appointment at UEA is **Dr Maru Morima** (Joint appointment between Biology and Chemistry). Her research is focused on ancient DNA. Her work has direct relevance to forensic investigations - for example, developing new methods for collecting DNA.

2. **Previous and Current partnerships**:
Home Office Scientific Development Branch (HOSDB)
Forensic Explosives Laboratory (DSTL)
Forensic Science Service (FSS)
Norfolk Police Force

3. **Translation of research**.
Our forensic research has yet to be translated into practice. However, *Intelligent Fingerprinting Ltd* is translating our research from the bench into usable products for the Police and Forensic providers.

4. **Opportunities and Barriers for the funding of research relevant to forensic science**.
The EPSRC Research Council funding body previously ran a "Think Crime" programme to encourage University based scientists from all disciplines to apply their research to tackle problems faced by law enforcement agencies. Unfortunately this funding stream has now come to an end.
Research outputs required by the police are often those that provide assistance with current operations or investigations. Therefore, the police requirement tends to be short-term. The law enforcement community needs to look to academia to develop novel concepts and technologies which may not be directed to solving their needs but can be adapted to it – the "Think Crime" programme is a prime example of how UK Research Councils, in consultation

with the Home Office Scientific Development Branch (HOSDB), can help deliver such science.

Clearly with the closure of the FSS it is even more essential that medium to long term research within forensic science continues to be funded. This type of research can be undertaken at universities. However, to provide a focused effort a strategic overview, driven by all key stakeholders (including the Home Office, Ministry of Justice, forensic providers and professional bodies and academics), would be essential.

5. **Important International networks**
European Network of Forensic Science Institutes (ENFSI)
International collaboration exists between researchers such as Professor Russell with research groups in: The Netherlands, Switzerland and Australia

6. **Other issues**.
In our experience it is recognised by stakeholders, i.e. police, forensic providers, academia, that research in forensic science in England and Wales lacks effective coordination and direction. Some Police forces sponsor numerous research mini-projects at local universities with little or no inter-force coordination. However research priorities should be set in consultation with all key stakeholders: Other bodies that should be included are UK Research Councils. The EPSRC ‘Think Crime’ programme was an excellent vehicle to ensure fundamental science was applied by scientists to solve problems faced by law enforcement agencies. This programme should be reinstated with a strategic overview body to ensure that funding is focused.

SCHOOL OF LIFE, SPORT AND SOCIAL SCIENCES, EDINBURGH NAPIER UNIVERSITY

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

   In the School of Life, Sport and Social Sciences (SLSSS), the research related to forensic science can be subdivided into the areas of detection of date rape drugs in alcoholic drinks; the development of new technology to measure breath alcohol; the subjective measurement of drug driving; and authentication of gemstones using Raman and FTIP spectroscopy.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?**

   We have an ongoing general collaboration with the Scottish Police Services Authority (SPSA) laboratory in Edinburgh in terms of toxicology and Raman / FTIR spectroscopy. The breath alcohol research is in collaboration with Concateno (formerly Cozart). The gemstone authentication is a joint collaboration with the National Museums of Scotland and we collaborate with Thermo Scientific

3. **Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?**

   The research collaborations in breath alcohol and gemstone authentication are in the process of being investigated for potential commercial translation. The main problem ,both specific to the aforementioned and in general, is that there is no mainstream source of funding for forensic practitioners who are working out-with the SPSA (or Forensic Science Service).

4. **What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?**

   I think that there are a number of opportunities for collaboration between mainstream academia and forensic practitioners and networks exist to facilitate this. The majority of new forensic related courses, particularly at postgraduate level, evolve from strong research expertise in the related area so there is definitely a foundation for formal research funding schemes to be established.

   The main problem is funding. There no forensic science specific funding scheme and it is not a stand-alone research area in any of the Research Councils. Additionally any mainstream funding that supports forensic type projects tend not to cater for the subset of forensic practitioners / researchers who have non-permanent positions and /or

do not have a Ph.D. The latter grouping will most likely have the experience and expertise necessary to engage in research relevant to forensic science.

Other problems are the difficulty in accessing and collaborating with SPSA (police labs); and the fact that there is no forensic science specific category for the Research Excellence Framework nor indeed was there for the previous Research Assessment Exercises.

5. **What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?**

   The most important is the European Network of Forensic Science Institutes (ENFSI) which is part of International Forensic Strategic Alliance (IFSA).

6. **Are there any other issues relevant to our terms of reference that you would wish to comment on?**

   In the UK the teaching of forensic science is now starting to be focussed in universities who have strong or developing forensic science research. It would useful if there was a mechanism for assessing this, perhaps aligned to the accreditation schemes for taught undergraduate and postgraduate programmes, which could then allow the creation of forensic science specific funding schemes.

UNIVERSITY OF GLAMORGAN

Research in the Division of Chemistry and Forensic Science, Faculty of Health, Sport and Science.

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

   Current relevant active projects include:

- The development of chromatographic and spectroscopic hair testing methods, for the analysis and monitoring of illicit drugs in users and potential users. Hair sampling provides an alternative approach to the traditional, more invasive methods of urine and blood sampling and also provides a significantly longer window of drug detection. This is becoming an established technique and can be used to monitor the use of a wide range of illicit compounds including alcohol. A potential future application is the testing of athletes' hair to monitor performance enhancing drugs. Currently, hair samples have to be sent to a laboratory for analysis. Future work will centre on the development of a system that can be used by police officers either at the scene or police station.

- The development of spectroscopic methods for the detection of illicit adulteration of foods. Work has centred on the detection of adulteration, the determination of the nature of adulterant and the geographical source of the adulterant. Future work to centre on the design of a hand held device that can be used for testing at the scene.

- The analysis of therapeutic and illicit drugs and their metabolites in waste water using combined chromatographic/spectrometric methods. This can provide consumption patterns of social groups and communities.

- The development and assessment of software for the enhancement of forensic odontological evidence including bite mark images.

- The detection and analysis of counterfeit currency using scanning electron microscopy and x ray microanalysis.

- Hand writing analysis by multiple measurements of letters and spacing.

- The design and construction of mock scene training facilities, including digital teaching aids, for police, fire and rescue, crime scene officers and students of forensic science.

Current research in the Information Security Research Group (ISRG), Faculty of Advanced Technology.

Information Security to include: Network Security, Intrusion Detection and Wireless Security. Penetration Testing and Vulnerability Assessment. Computer Forensics and Digital Evidence Visualisation. Threat Assessment and Risk Management. To investigate the nature of

threats posed to information systems by various agents, and to understand the potential impact of a successful attack.

Objectives are:

To create cyber-based early warning systems capable of detecting and responding to network-based attacks targeted at an organization's information infrastructure.

To investigate issues relating to open source forensic analysis tools and techniques, and to analyse the concepts relating to data sharing and evidence visualization.

To develop tools and techniques that will allow us to assess, mitigate and manage vulnerabilities in an open heterogeneous distributed networked environment.

To examine the issues surrounding the development and deployment of secure wireless mobile networks computing devices

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Much of the hair analysis development work has taken place and continues to be in collaboration with a commercial service provider – Concateno TrichoTech. Collaborations of the information security research group (ISRG) include: The defence evaluation and research agency, CESG/GCHQ, Northrop Gruman.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

- Methods and protocols for hair testing have been transferred and adopted by the collaborating partner for commercial use. The service is increasingly being used applied to Work place testing – including pre-employment screening and as part of drugs and alcohol policies and in monitoring safety-critical workers.

- Criminal justice system – reducing drug and alcohol related crime is a policy of most Governments. Specific examples include corroboration of suitability for custody of children and alcohol habits of drivers in road accidents.

- Healthcare and Medicine – tests can be used to assess patient suitability for treatment or surgery e.g. screening prior to liver transplant or in alcohol treatment facilities to determine the extent and duration of abstinence or reduction in consumption.

4. What do you see as the opportunities for and the barriers to, the funding of research relevant to forensic science?

Currently the best opportunities are to be gained by from collaboration with forensic service providers in the private sector or forensic equipment/instrument manufacturers. There have been some opportunities to apply for funding from central funding bodies such as the Engineering and Physical Sciences Research council (EPSRC); however calls for specific forensic projects are few. The ISRG have been successful in obtaining funding under the European Commission under Framework V – IST Programme.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

International links tend to be forged via traditional academic networks including various user groups, events organised by professional bodies and subject specific conferences. Personal membership of foreign forensic science organisations, for example, the American Academy of Forensic Science can help to facilitate collaborations.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

Forensic science research that is undertaken in academia is firmly linked with forensic science practice and practitioners. Future research would benefit from an increase in the provision of collaborative funding opportunities including CASE and match funding.

UNIVERSITY OF GLASGOW

Re: Forensic Science Research and Development

Many thanks for your letter of 16th February affording us the opportunity to contribute to your review of research and development activities that are relevant to the future of Forensic Science in the UK. I have consulted with several colleagues and I am pleased to enclose our comments below.

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

We have a range of collaborations within the College of Science and Engineering that are providing a multi-disciplinary approach to Forensic Science. We believe that this is the only way to address the challenges being posed to digital forensics, in particular by the introduction of Cloud computing techniques. In the past, police agencies could seize the physical hard drives that were used to store digital evidence. This is becoming more and more difficult with cameras, MP3 players etc all offering significant storage capacity. However, the increasing use of Cloud computing enables suspects to distribute their data across hundreds of servers in a fashion that can also make it difficult for service providers to reconstitute the files that are stored on their infrastructures. The storage services being offered by Microsoft, Amazon, Google and others are undermining first generation tools for digital forensics. At the same time, the massive increase in storage capacity is stretching our ability to identify relevant files from the mass of other digital data that might be 'seized' in an investigation. Our solutions involve joint research by systems engineers (e.g. Prof. Sventek) and information retrieval experts (Prof. Jose) with support from specialist hardware devices including FPGAs (Dr Vanderbauwhede).

In the Humanities Advanced Technology and Information Institute (HATII), part of the School of Humanities of the University of Glasgow, has placed a high priority on the development of postgraduate training and research in the field of Computer Forensics and E-Discovery, and believes this to be a major area for concern in future security of corporate IT systems which should be a priority area for government investment. The MSc in Computer Forensics and E-Discovery was established by the University of Glasgow in 2008 and is one of the few postgraduate programs in the area. The HATII course is unique in bringing together researchers, practicing professionals and teachers from a wide range of disciplines, including computer science, digital humanities, and library and archival studies. The programme curriculum covers an introduction to the field; legal and regulatory frameworks; introduction to security; systems and networks; research methods; computer forensic processes and investigative techniques; managing and presenting digital evidence; security and cryptography; advanced research readings in computer science. The programme is designed to produce professionals in the field who have been exposed to an unmatched range of knowledge and experience.

It should be noted that training of this kind requires dedicated specialist computer facilities, which Glasgow is fortunate in possessing, but the availability of such laboratories limits the scale of potential training, and further investment is required here. The course is narrowly-based in terms of staff

resources, the core expertise being essentially limited to one member of staff, and there is a need to create a larger cohort of expertise in the field.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

The College of Science and Engineering has a long running collaboration with several police agencies through a joint Masters program on Digital Forensics. Students on this course are frequently serving police officers or involved in other aspects of the criminal justice system. Speakers include members of the Scottish Crime and Drug Enforcement Agency etc. See for example: http://www.gla.ac.uk/departments/hatii/postgraduate/msccomputerforensicsande-discovery/cfedseminars/. Other members of staff have individual contacts, for example with the Intelligence Agencies through the CONTEST programme.

The course convener of the MSc in Computer Forensics and E-Discovery works closely with specialist units in Strathclyde Police and elsewhere, and the availability of government-funded focuses of expertise is important for continued development in this area.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Much of the research within the College of Science and Engineering remains at a relatively early stage of technology readiness, given that the threats we have identified to first generation digital forensics are only just becoming available to potential suspects. However, initial pilots of the techniques that we are using have been fielded by UK agencies principally connected with Cyber Defence initiatives across the MoD, for instance as part of the DSTL programme. We intend that our civil work on digital forensics should complement these wider government funding initiatives.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

A key issue in the College of Science and Engineering is that over the next 5-10 years, we will need to recruit support from a range of engineering disciplines that have not previously been engages in digital forensics. In particular, information retrieval experts must support the work of systems engineers if we are to face the challenge of large scale distributed computing for mass market applications. Another area that is of particular concern relates to the use of Social Media in a range of criminal activities – hence in Glasgow we have teams of social scientists working with systems engineers on the implications of these technologies. Funding barriers often arise when transferring the products of this research into useful tools that can be applied by the relevant agencies – there are communications gaps between the researchers and the end users; especially in areas that are not traditionally part of Forensic Science.

HATII is seeking to develop an active research programme in Computing Forensics and E-Discovery, for example securing funding from the University's Chancellor's Fund last year for a pioneering study of the security

of mobile computing devices. Members of HATII also contributed to the report published last year by the Council of Library and Information Resources in the United States on digital forensics and cultural heritage: http://www.clir.org/pubs/abstract/pub149abst.html, which confirms the importance of developing and expanding research capacity in this area. HATII sees continued government engagement and investment in this field as essential to its future development.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

The European Commission has funded a range of initiatives under DG-JLS to support the technical and socio-technical development of digital forensics. Much of this work is almost entirely overlooked by UK agencies even though they have assessed a range of innovative approaches to common problems. Notable exceptions include the engagement of CPNI in some of these programmes.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

N/A

UNIVERSITY OF GLASGOW (2)

Forensic Science Research and Development

The following response has been submitted by the Forensic Toxicologists based in Forensic Medicine and Science at the University of Glasgow. The Forensic Pathologists have not contributed to the response as it is understood that forensic pathology and forensic medicine are excluded from the scope of the current review.

Background Information

Forensic Medicine and Science (FMS) within the University of Glasgow has a long established reputation in the fields of forensic toxicology and forensic pathology with the first Regius Professor of Forensic Medicine appointed by the Crown in 1839. FMS has provided both pathology and toxicology services to the Crown Office for more than fifty years and is one of the largest departments of its kind in Western Europe.

In addition to providing a service to the Crown Office, the Forensic Toxicologists provide consultancy services to a number of forensic service providers throughout the United Kingdom and regularly attend court as expert witnesses. Staff are actively involved in advancing the field of forensic toxicology through research and teaching and sit on a number of committees involved with setting and improving industry standards.

The toxicologists are therefore in the unique position of providing a service as practising forensic toxicologists (accounting for approximately 70% of time commitment), in addition to teaching (20%) and carrying out research (10%) as academics.

Current Research Activities

Scale of R&D

The facilities within FMS include the routine laboratories which have restricted access in accordance with ISO17025 accreditation and shared research and teaching laboratories. The majority of the equipment available for research is second-hand and is also used for teaching. However, research time is also apportioned to the state-of-the-art equipment available within the routine testing laboratories. No formal R&D budget is available, although funds in the region of £25,000 are reinvested on an annual basis to develop the services provided. No member of staff within FMS is dedicated to research activities alone. Of the 14 staff directly employed within the toxicology laboratories, approximately 2 full-time equivalents are apportioned to research.

The majority of the research carried out within FMS is completed by post-graduate research students under the supervision of the toxicologists. There are currently 2 full-time and 1 part-time research students studying within FMS.

Scope

The research carried out within FMS is entirely related to the field of forensic toxicology. Research
interests range from developing methods for the analysis of new designer drugs1 or new prescription
medication2 to investigating the use of alternative matrices3 as a tool in drug facilitated crime.
On-going projects within FMS which require further investigation include:
- The stability of drugs and alcohol under different storage conditions;
- Development of broad drug screening methods;
- Investigating oral fluid as an alternative matrix (e.g. roadside drug testing);
- Investigating alcohol biomarkers in alternative matrices
- Interpretation of drug concentrations in post-mortem samples

1 Hazel Torrance, Gail Cooper. The detection of mephedrone (4-methylmethcathinone) in 4 fatalities in Scotland. **Forensic Science International, Vol.202(1-3), 2010, pe62-e63.**
2 Ahmed I. Al-Asmari, Robert A. Anderson and Gail A.A. Cooper. Oxycodone-Related Fatalities in the West of Scotland. **J. Analytical Toxicology, Vol.33(8), 2009, p423-32.**
3 Karen S. Scott. The use of hair as a toxicological tool in DFC casework. **Science & Justice, Vol.49(4), 2009, p250-3.**

Impact
The development of methods for new designer drugs and prescription medications has had a direct impact on the completion of casework and the subsequent publications have helped other laboratories to expand their testing capabilities both in the UK and worldwide.

Investigating the stability of drugs and alcohol and the use of alternative matrices has increased our understanding and ultimately improved our ability to interpret case findings.

Partnerships
Research collaborations are currently on-going with:
- The Centre for Drug Misuse Research, Glasgow (using oral fluid testing as a tool to evaluate the success of different treatment options for heroin addiction);
- The Princess Royal Maternity Hospital, Glasgow (investigating the prevalence of drugs and alcohol biomarkers in meconium samples collected from newborns);
- Center for Human Toxicology, University of Utah, USA (developing methods for the analysis of dietary supplements with potential for misuse)

Funding
Funding through competitive applications for research grants is well established across all othersectors, e.g. medicine, engineering and chemical or biological sciences, but there is no equivalent structure in place for organisations carrying out forensic research.

FMS has historically secured funding from:

 collaborations with industry
 consultancy income generated by the toxicologists
 international students whose governments provide grants for their students to study in the UK.

The lack of grants available for Forensic Science research prevents funding of PhD studentships for UK-based students wishing to study in the UK. In addition, the research projects undertaken are limited by lack of available funds.

Access to the Latest Advances in Technologies/Techniques

As FMS is part of an academic institute, we have full access to journals and can easily access the latest published research in our field. Staff and student attendance at national and international conferences is actively encouraged, where funding is available, and provides an excellent forum for dissemination of knowledge.

FMS actively supports the sharing of knowledge between forensic toxicologists and over the past two years has hosted two forensic toxicology conferences attended by over 100 delegates from around the UK, Europe and the USA. The main focus of the events was to provide a forum for forensic toxicologists from the UK to meet and share best practice and current research activities. It is widely acknowledged that many bench-level forensic toxicologists in the UK are unable to attend conferences due to restricted travel budgets and local meetings are organised to help facilitate greater attendance from UK delegates. The UK and Ireland Association of Forensic Toxicologists (UKIAFT) plans to host a conference-style AGM to encourage UK-based forensic toxicologists to attend.

Links between Forensic Science Research and Academia

As a service provider and an academic institute, the links are intrinsically, although not exclusively inhouse. Glasgow University is a research-led teaching institute and the research carried out within FMS is primarily focused on improving the forensic toxicology service we provide by helping us to better understand and interpret casework findings.

Contribution from International Research Networks

Staff within FMS are actively involved in research, developing new methodologies and evaluating technological advancements and this has positioned us at the forefront of innovation in forensic toxicology. As a result FMS staff have been invited to participate in European funded projects including The British Roadside Impairment Testing Evaluation (BRITE) project funded by the Department for Transport (DFT) and ROadSIde Testing Assessment (ROSITA I) funded by the European Commission under the Transport RTD Programme of the 4th Framework Programme. The BRITE project was carried out to monitor the effectiveness of the UK field impairment test, as used by the Police. Oral fluid specimens were collected from drivers suspected not to be impaired through drug use and analysed to identify the true use of drugs in this population of drivers. The ROSITA project analysed urine and oral fluid samples to evaluate the reliability of roadside

drug testing devices and assessing their roadside practicality. Additionally, FMS was selected as the UK laboratory for the European project, Impaired Motorists, Methods Of Roadside Testing and Assessment for Licensing, (IMMORTAL) funded by the European Commission under the Transport RTD Programme of the 5th Framework Programme for the testing of oral fluid samples obtained from a random
selection of drivers at the roadside for licit and illicit drugs.

There are many opportunities to collaborate with our international colleagues on projects that will directly benefit forensic toxicology in the UK but lack of funding remains the main obstacle.

GLYNDWR UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

(a) A collaboration with North Wales Police on the project to investigate the technique to develop finger prints on egg shell.
(b) A member of staff is currently operational forensic archaeologist working with police and LGC in cases involving major crime.
(c) A member of staff is also involved in the training of next generation of forensic scientists, which is a collaborative work with University of Exeter and University of Oxford.
(d) We will enhance and expand the collaboration with regional and national police and forensic service organisations on particular research projects in forensic science in the future.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

(a) North Wales Police (fingerprint on eggs).
(b) Norfolk constabulary (GIS and cold case review).

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

We have been translating our strength in analytical chemistry into forensic investigation. In the near future, we will also look into the opportunity to apply our experience in material and nanotechnology in the forensic practice. The major difficulty is to secure government funding to support such research work.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

(a) Research criteria can be barriers.
(b) Interdisciplinary collaboration can be both opportunities and barriers.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

(a) International Forensic Science Symposium (IFSS).
(b) International Association of Forensic Sciences (IAFS)

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

None.

SCHOOL OF APPLIED SCIENCES, UNIVERSITY OF HUDDERSFIELD

I am a Senior Lecturer in Forensic Science in the School of Applied Sciences at the University of Huddersfield and have been a forensic biologist for approximately ten years, starting as an operational DNA/Body Fluids Reporting Officer with the Forensic Science Service. Since becoming a Senior Lecturer, I have been research active. This has given me a view of forensic science research from an operational perspective as well as from an academic perspective. I am also the Director of West Yorkshire Forensic Services, a forensic science consultancy and training company.

My contribution to the review is as one of the main researchers into the forensic sciences within the School of Applied Sciences. Please find my response below:

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Currently, research is being carried out into:-

- Forensic Genetics – Augmenting current DNA profiling techniques and the forensic applications of RNA analysis
- Use of recombinant botanical DNA and up-converting phosphor for anti-counterfeiting purposes (in conjunction with ADNAS, a Stony Brook University based company in New York)
- Clothing Damage Analysis – Quantification and correlation of damage and weapons
- Forensic Entomology

In addition to this research, there are also some smaller projects being carried out in response to operational requirements.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc?

Currently, we have research collaborations with the DNA profiling laboratory of the Textile Centre of Excellence (who conduct DNA profiling of botanical traces in Cash-In-transit/armed robbery cases). This partnership is in the form of a Knowledge Transfer Partnership (KTP) a government funding scheme.
We also have a research 'co-operation' with the DNA profiling unit at the Food and Environmental Research Agency (FERA) at Sand Hutton, York which has led on from a previous Memorandum of Understanding.

We have previously had a research partnership with Key Forensic Services Ltd who contributed to our research into recovery of DNA from discharged cartridge casings and firearms.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

One of our research strands is the development of more robust and defendable methodology in the field of Clothing Damage Analysis. This field is

notoriously subjective and is largely dependent one person's opinion, which is not based on any rigorous scientific principle. For example, in order to determine if a knife could have caused the damage to a t-shirt, the analyst takes that same T-shirt, places it round a polystyrene box and stabs it with a suspected weapon. The two areas of damage are then visually compared to see if they look alike or not.

Given the current climate of increasing regulation and oversight of forensic evidence, we felt that it would be useful to carry out research in to quantifiable aspects of the clothing damage and determine whether there was any correlation between this aspect and some measurable aspect of the weapon. We were able to demonstrate the proof of principle.

However, when we tried to disseminate our findings (through publication submissions and consultation with colleagues in the forensic science providers), we were met with a lot of resistance. The general feeling was that the current methodology was 'good enough' and did not really require any other methods. So from our experience, we find that current forensic science providers do seem to have a reluctance to accept alternative methods, unless their evidence is often legally challenged (such as with DNA evidence).

So unless there is an incentive (i.e. loss of revenue due to perceptions of poor quality or adverse judgments), forensic science providers seem reluctance to improve their procedures. This opinion is also based upon personal experience during my employment in the FSS.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Firstly, the barrier to funding of relevant research is quite considerable. There is no UK based research council that funds Forensic Genetics. The remits of most research councils do not include Forensic Genetics. Occasionally, the EPSRC does a crime related funding initiative, but these projects usually have to have an element of chemistry or engineering (such as Lab-on-a-chip).

The Leverhulme Trust prides itself on funding projects that do not fall within the remit of the usual research council; however, in order to obtain a grant you have to pass a review panel and this is highly competitive. This unfortunately encounters another problem in that you have to have an established reputation – this leads to a Catch-22 situation where you cannot develop a reputation without funding!

There is very little relevant forensic genetics research carried out in the UK universities, as much of the research comes out of the FSS or LGC Forensics. This is in stark contrast to other countries where the Universities are very active and crucial to forensic genetics development (such as the University of Amsterdam in the Netherlands). This appears to have given rise to the concept that UK universities are generally not very good at forensic genetics research and therefore given a much lower priority by research councils.

However, this could lead onto opportunities. With the closure of the FSS R&D, the forensic genetics research output is going to fall significantly, therefore there needs to be an injection of research funding to the field of forensic genetics. One option for this is the formulation of the Forensic Research Council (FRC). The remit of this council should then be primarily to enhance forensic genetics research within the UK universities thus preserving and improving the UK's reputation as a World Class Provider of DNA research. This will also continue the nurture and development of the R&D staff within the FSS who will be looking for jobs. If they could seek employment with the universities, then all that is happening is rather than closing a world class research department, it is merely a 'redistribution', which should be supported by the UK government.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

International Networks are usually vital for research, but again these networks tend to favour research from the forensic science providers and largely overlook the university contributions. For example, if you consider the European Network of Forensic Science Institutes. This organisation holds a lot of influence of the direction of forensics, but has very little input from Universities in the UK.

However, I currently have an Intern from the University of Amsterdam.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

There is very little support for forensic genetics research within the universities. This is generally due to the very active FSS R&D department and it is very difficult for academic research groups to acquire sufficient funding to compete on a similar level.

One thing that is obvious is that there needs to be more support from the government in terms of Forensic Science research within the universities.

I hope you find this information useful and should you need any further information or clarification, please do not hesitate to contact me.

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UNIVERSITY OF HULL

1 Work at Hull relevant to forensic science

Through the EPSRC Think Crime call a project was funded to develop lab-on-a-chip DNA profiling technology EP/D040930 (At scene of crime DNA characterisation – April 2006-June 2009), which then received follow on funding though grant EP/H007385/1 (Commercialisation of Lab-on-a-Chip technology for DNA profiling July 2009 – June 2010) and is currently supported by a commercialisation grant from Yorkshire Concept. This funding has allowed an integrated micro fluidic device or chip (Lab-on-a-Chip) with an associated operating system to be developed which enables DNA to be extracted, amplified by PCR, and detected in approximately one hour. As this project was undertaken to meet the stringent requirements of the Forensic Science Service (FSS), a partner on the grant, sample integrity and the elimination of cross contamination have been key factors. In addition we are currently running four PhD research projects funded by the Saudi Government to develop a range of lab-on-a-chip technology for forensic applications. There is considerable opportunity to extend overseas interest in the development of forensic based technology there is little interest from within the UK with the exception of dstl who are currently funding a feasibility project.

2 Previous and current research

This has been exclusively with FSS and dstl.

3 Translation issues

We have experienced some serious barriers in progressing the technology developed from the original EPSRC project, as outlined above, to the end user. There are three clear issues i) the disruptive nature of the technology has made implementation very difficult for the end user and ii) there is no commercial vendor available to provide the technology to the end user and iii) current technology providers see the emerging technology as unwanted competition and actively attempt to stop its commercialisation.

4 Opportunity and barriers for research funding

The forensic community see there subject as very specialised but this is only true in the delivery of the science and the underpinning methodology is in fact no different to other areas of scientific research. This belief in some unique aspects of the science has created a significant barrier to a) the development of the science and b) engagement with the wider community. There is considerable opportunity to develop novel methodology and new technology which will be directly relevant to fighting crime. The issue is one of engagement as both the end user and academic communities are do not have a well developed forum such as that that exists with the pharmaceutical industry for example. Directed areas of research along the lines of medical type research would perhaps help break down barriers and offer visibility to both sides.

5 International networks

The international networks are worse than the national ones which are in them selves almost non functional (see 4 above). There is however some

involvement at the governmental funding level with selection panel representation, the current Dutch (NWO call on forensic research funding, SJH is on the panel) is an example.

KEELE UNIVERSITY

1. What work relevant to forensic science is being done at Keele University and what are future opportunities?

- Forensic geophysical research currently includes, monitoring test sites to provide comparison data for forensic search teams, periodically advising search teams on optimal geophysical detection techniques and physically assisting forensic searches, including environmental forensics (includes funding from EPSRC and industry, and funding from EPSRC for promoting public engagement in Forensic geoscience research, including the Staffordshire Hoard.
- Forensic geophysical research is developing through colleagues currently liaising with Armed Forces personnel to assist with IEDs, UXOs and other forensic targets to improve detection rates.
- Forensic entomology research is currently focussing on how chemistry can help us to age and identify insects found on corpses. This is a very new niche area and initial results are very promising and suggest this will be very valuable for future casework where insects are involved (funded by NERC and BBSRC)
- Development of X-ray micro-focus imaging and computer software in relation to airport security in collaboration with the Forensic Science Service (funded by EPSRC)
- Development of novel ambient mass spectrometry, specifically including plasma-assisted desorption ionisation mass spectrometry (PADI-MS) for rapid, sensitive *in situ* non-destructive forensic analysis
- Forensic analysis of inks
- Analysis of drug metabolites and saliva
- Significant number of peer-reviewed publications in the Forensic Science literature in recent years
- Several PhD students in the areas of Forensic geophysics and Forensic Entomology, and funded summer students in other areas of Forensic Science, including forensic analysis of inks
- Participation in significant number of national forensic science and analysis research and teaching conferences.

2. What previous and current research partnerships do you have with forensic science providers?

- Current geophysical partnerships include the UK National Policing Improvement Agency National Search Advisor, HODSB and the Australian FBI
- Numerous commercial geophysical search companies, e.g. RSK STATS Ltd., Terradat Ltd., Met Surveys, Fugro.
- Forensic Science Service
- National Physical Laboratory
- Increasing links being established with the Health and Safety Executive, Buxton (Keele is the closest research-intensive University)

- Comprehensive collaborations with forensic geophysics researchers in the UK, including Birmingham, Bournemouth, Cranfield, Glasgow, Macaulay Institute, University of Aberdeen, Queen's University of Belfast, Staffordshire University, University of Central Lancashire, and internationally, including, University of Tennessee, Kentucky, USA, Australian FBI and University of Ontario, Canada.
- Forensic Entomological research involves collaborations with experts at the Forensic Science as well as with experts at the Natural History Museum, and several European Universities.
- In situ analysis research involves close collaboration with University of Nottingham and the Forensic Science Service and the National Physical Laboratory
- Previous partnerships included the Metropolitan Police geophysical search team (now re-allocated) and SOCA.
- Partnerships with a number of Forensic Science practitioners in relation to our teaching programme.

3. Good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Good examples

- Used test site data to assist with 2008 North Wales Police search for buried murder victim (published in Forensic Science International in 2010.
- Used geophysical knowledge to assist NIEA in 2010 to quantify illegal toxic waste extent, quantity and potential contents in environmental case (currently in court).
- Research in forensic entomology developed out of research focussed on the chemistry of insects which was then applied into the area of forensic entomology.
- Development of novel ambient mass spectrometry, specifically including plasma-assisted desorption ionisation mass spectrometry (PADI-MS) for rapid, sensitive *in situ* non-destructive forensic analysis

Problematic

- Geophysics currently used as forensic search tool on a sporadic basis. It is not in the Police Service search handbook, something Keele, collaborators and others are trying to rectify.
- Currently researching burials in coastal environments as difficult to identify (liaising with search teams looking for NI 'Disappeared').

4. What are the opportunities for, and the barriers to, the funding of research relevant to Forensic Science?

Opportunities

- As forensic science is a very cross disciplinary research area, this is generally a positive aspect in applying for funding.
- EU FP7 to fund European research teams – but the application process very complex.
- Environmental forensics is a growing area with illegal waste disposal increasing.
- Development of novel, highly sensitive, *in situ* analytical techniques with forensic application
- There are an increasing number of new SMEs establishing themselves and operating in niche areas in forensic science, especially in the forensic analysis sector, exploiting new advances in analytical techniques, and these offer some funding potential (although see comment below re. barriers).

Barriers

- As research groups in the forensic science area are generally quite small this can make it more difficult to successfully apply for research funding.
- EPSRC and NERC have ceased funding PhD students via research grants.
- Research such as forensic geophysics and forensic entomology also doesn't really fit readily into the remits of the relevant research council funding bodies (NERC, EPSRC and BBSRC)
- Most commercially-funded research is for short-time projects, not large-scale or longer-term which would allow research teams and knowledge to be built up.
- Obtaining funding to proceed beyond initial proof of principle experiments in developing new analytical techniques for application in forensic science is very challenging within a funding system geared towards either fundamental research or commercial exploitation, rather than maximising the potential from such proof of principle research.
- The above makes it difficult to maximise opportunities with the increasing number of SMEs keen to commercial such new analytical techniques

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you wish to draw attention to?

- Membership of the International Union of Geological Sciences Geoforensics International Network (GIN) which draws together global expertise in geoforensics, advise on cases and provide resources where required.
- Collaborating with Australian FBI.

- As crime isn't restricted to boundaries, international collaboration is very important.

- In the area of Forensic Entomology there is a need to collaborate internationally to see the effect of different climates on insect development. Collaborations are in place with forensic groups in various countries in Europe and outside Europe.
- Collaboration in place with the University of Tennessee, Kentucky, and the associated 'Body Farm' (the Centre for Human Anthropology)

6. Any other relevant issues commenting on?

- Forensic Geophysics research is focused on both forensic searches and environmental forensic investigations (stakeholders include the Environment Agency, NIEA and NERC and EPSRC).
- Forensic science research is increasingly important and relevant, and various groups are currently working on new areas, sometimes a niche area, to develop new forensic analytical techniques and improve knowledge and scientific robustness of forensic science. There is some concern that some of these smaller niche research areas may not be able to sustain themselves and there will be more of a focus on mainstream issues at the possible expense of future developments.
- There is a great deal of research expertise and equipment in analytical sciences that is available which is increasingly being developed and utilised in a forensic context, but there is considerable scope for this to increase further.

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KING'S COLLEGE HOSPITAL DENTAL AGE ASEESSMENT TEAM - 2011

Dental Age Assessment (DAA): Setting International Reference Standards

Introduction

Dental Age Assessment (DAA) has been used for over 150 years[1]. Other commonly used techniques are psychological development, height, and weight[2], hand-wrist skeletal development[3], sterno-clavicular joint maturation[4], tooth development[5,6], dental root canal width[7], and / or tooth apical foramen width[8]. DAA is needed to assist in the identification process of cadaveric remains[9] as well as living subjects. Studies indicate that tooth development provides age estimates closer to chronological age than any of the other techniques[10,11,2]. Even under the extremes of severe systemic illness dental development is affected only to a small degree[12,13]

The Dental Panoramic Tomograph (DPT) captures the whole of the dentition on a single image and is widely used in clinical practice and provides clinical investigators with a uniquely effective way of assessing dental maturation. This has led to the use of a number of different systems for generating quantitative data from defined stages of tooth development[14]. Methodological differences have made it difficult to compare different ethnic groups. Recent work has demonstrated significant differences in Dental Age estimation between Afro - Trinidadians and United Kingdom Caucasians (Moze, K. MSc. 2009 in preparation). Valid comparison of different ethnic groups requires a database based on large numbers of radiographs from individuals of known ethnicity.

To a significant extent this has been achieved with the preliminary development of the **D**ental **A**ge **R**esearch **L**ondon **In**formation **G**roup (DARLInG) database. This comprises over 7,300 subjects of UK Caucasian, Afro-Trinidadian, and mixed ethnicity. To enable comparison between ethnic groups it is essential to acquire similar numbers for each identifiable human group. The current estimate is 1,200 cases viz 600 females and 600 males per IHG to enable validity testing of the DARLInG database output[15,16].

Purpose of the Study

(1) To create a Reference Data Set (RDS) of tooth development stages of permanent teeth discernible on DPTs for racial, ethnic and identifiable human groups.

(2) To use the RDS for specific racial and ethnic groups to determine the accuracy of DAA.

Methods and Materials

Material used for Assessments

The sample for the study will be Dental Panoramic Tomographs (DPTs) from the radiographic archives held in any community, regional, or national centre

from any participating dental centre. These DPTs[16] will provide material for assessment of developmental stages of all permanent teeth from the age of approximately 4 years to 26 years old. The two overseas centres initially participating will be The University of Hong Kong and the University of Amman in Jordan.

For the International Reference Data Set the method of assessment will be the 8 Stage system[17]. This has the advantage of being widely accepted as a reliable method of assessing TDSs. This is because it is easy to use and a number of investigators have demonstrated high levels of both intra and inter rater agreement[18].

Data Processing
All acetate DPTs will be converted to a digital image for storage.

For each subject up to 18 Tooth Development Stages will be identified – one for each of the permanent dentition tooth types. In addition, the two third molars on the right side are included. The distribution of ages for the presence of each tooth developmental stage will then be derived.

Data Protection

Ethical approval has already been provided by the KCH South London Regional Ethics committee.

Statistical Considerations

Reference Data Sets
All data will be manipulated and analysed using suitable statistical software, for example Stata version 11[19]. The summary data will be produced comprising: N, n-tds, mean, standard deviation, median standard error, 99% confidence interval, smallest value, largest value, range and probability values comprising 0.05th, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 99.5th for each TDS. This large array of data will comprise the Reference Data Set which will be partitioned by gender and ethnicity.

Validation

The reliability of the Reference Data Set for each racial, ethnic and identifiable human group will be assessed by collecting ethnically unique study groups comprising 50 females and 50 males and using the Gold Standard of chronological age and visually confirmed ethnicity. Different statistical approaches will be assessed comprising average of raw TDS scores[20], weighted scores[15] linear regression[7], logistic regression[14], and the mathematical methods used in meta-analysis[16].

What does DAA mean to the individuals who request this service?

The use of DAA will help children trafficked in to the UK for purposes of sexual abuse as the age of these children will confirmed and enable criminal

prosecutions to be brought against the perpetrators. Unaccompanied asylum seeking children (UASC) will be provided with an age that enables carers to provide appropriately for these children. Minors with forged documents, brought to the UK for arranged marriages will be protected by the ability of social workers to seek DAA. Important Age thresholds of 10 years, 13 years and 18 years in criminal law are identifiable using DAA

In Summary, this project will provide uniquely comparable data for different ethnic groups across the world. The formidable task of acquiring sufficient numbers for the local Reference Data Set is something that can only be accomplished by overseas investigators working in collaboration with DARLInG.

Personnel required

1. Clinical Professor 2 days per week (approx. £42,00 per annum gross)

2. Senior Clinical Research Fellow 2 days per week (approx. £23,000 per annum gross)

3. Secretarial and Administrative Support 3 days per week (approx £10,000 per annum)

4. Database support, 2 days per week (approx. £25,000 per annum).

Start Date

The DARLInG project has received full Research Ethics Approval from the South London Research Ethics committee (6 January 2011) and full Research and Development
The work is currently in an advanced state of development and requires funding to be continued. The Reference is R&D Approval for KCH110-037 Dental Age Assessment which was granted on 12 March 2011. We are now able to proceed.

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Submitter details:

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KING'S COLLEGE LONDON

1. **What work relevant to forensic science is being done in your group / University and what are the opportunities for the future ?**

   The principal areas in which leading-edge, innovative research in forensic science is being undertaken at King's College, London (King's) are:

   - Improved location, recovery and analysis of forensic evidence (including body fluids, DNA and illicit drugs);
   - Development of new methods and instrumentation for forensic analysis;
   - Toxicology;
   - Computer forensics;
   - Ethical issues associated with use and public governance of forensic technologies (with specific focus on DNA).

   We believe that, in order to maximise the contribution and value delivered to the Criminal Justice System (CJS) by forensic science, future research must address key aspects of the forensic process, from detection of evidence through to its presentation in Court. Correspondingly, we consider the following as high priority opportunities for future research:

   - Development of technologies capable of changing forensic processes and delivering efficiency savings to forensic science providers, the police and the wider CJS (e.g. technologies aiding detection and identification of the best sources of evidence);
   - Fundamental scientific research to enable understanding and robust interpretation of forensic evidence (e.g. identification of the most discriminatory drug metabolites for toxicological analysis, or identification and interpretation of the distribution of drug metabolites in alternative matrices including hair, fingerprints and waste);
   - Evaluation of how juries perceive scientific evidence, in order to develop best practice in the effective communication of scientific evidence in Court and ensure that its meaning, context and relative importance is understood clearly and accurately by jurors.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc ?**

   King's enjoys a wide range of research partnerships with UK forensic science and police organisations; previous and current partners include:

   - The Metropolitan Police Service (Directorate of Forensic Services and, Digital and Electronic Forensic Service);
   - The Forensic Science Service;
   - LGC Forensics;
   - Cellmark Forensic Services;
   - ROAR Forensics;
   - Mass Spec. Analytical;
   - Intellas UK.

   In addition to these CJS partners King's has current collaborations with UK forensic science research organisations (including HOSDB, Dstl's Forensic Explosives Laboratory, and NPL) and commercial partners (including Foster and Freeman, Waters, and ThermoFisher Scientific). We strive to be a forensic science research hub, linking equipment manufacturers and specialist research centres, with end-users to develop solutions to important forensic science problems (e.g. the "Light-it Up" project for evidence location).
   Through its MSc programme in Forensic Science, which includes a practical-based, 4-month scientific research project undertaken with a forensic science provider, police force or research institute, King's continually initiates new research partnerships.

3. **Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic ?**

   Within King's we are currently undertaking a range of projects to translate our research into forensic science practice; examples include:

   - Independent, scientific evaluation of three commercial semen detection kits for the Metropolitan Police Service. Together, we are currently implementing the best performing kit in the 'Haven' Sexual Assault Response Centres, giving staff new capability in the rapid, *in-situ* and cost-effective location and recovery of forensic evidence.

- Development of "Digital Forensic Advisor", a software system to guide forensic examiners through the most cost-effective examination pathway for common digital crimes, in collaboration with Hong-Kong University and the Hong-Kong Customs and Excise Digital Forensics Laboratory. Commercialisation of this software is currently being undertaken with Intellas UK.

In contrast, translation of successful, well-received research has proven difficult with limited sources from which to secure continuity of funding for commercialisation; this is illustrated clearly by the "Light-it Up" project. Funding for the early-stage research was secured through the EPSRC "Think Crime" programme, however further development of the "Light-it Up" reagent into a commercial product has stalled due to difficulties in securing follow-on funding. Absence of such funding has prevented collection of the data package required for licensing of this technology to a commercial partner.

4. What do you see as the opportunities for, and barriers to, the funding of research relevant to forensic science ?

Over the last 10 years King's has secured the majority of its forensic science research funding through the EPSRC "Think Crime" dedicated forensic research call (67%), and delegated UK Research Council funding schemes (13%).
Obtaining funding for research relevant to forensic science has been more difficult than for other disciplines. The main barriers, encountered frequently, are:

- The inter-disciplinary nature of forensic science results in this area falling between the core remits of the main UK research councils, making funding for this discipline particularly difficult to secure; a problem highlighted to the Parliamentary Science and Technology Committee by Sir Alec Jeffreys in 2004.

- The successful EPSRC "Think Crime" programme provided funding matched specifically to the inter-disciplinary nature of forensic science. Since this programme ended in 2006, the absence of dedicated funding calls has limited the accessibility of a range of RCUK administered schemes, from funding for basic research, through funding for establishment of pre-competitive research consortia, to leveraged funding schemes (e.g. CASE) to initiate new Industry-University partnerships, to researchers in forensic science.

- The restrictive funding landscape for forensic science both limits the ability of the brightest undergraduate and masters students to enter forensic science research through PhD studies, and makes securing initial funding as a young academic researcher

even more difficult in forensic science than other disciplines. This jeopardises the ongoing development of forensic science research capability in the UK.

5. **What are the important international networks and how useful are they? Do you have any specific collaborations that you would wish to draw to our attention?**

Important international forensic science networks, in which King's has participated, include:

- European Network of Forensic Science Institutes (ENFSI) constituent working groups;
- The International Association of Forensic Toxicologists (TIAFT).

These networks have provided a forum for the dissemination of our research. Generally, we have not found them valuable either in promotion of collaborative partnerships or in developing international research funding opportunities. In our experience, these networks, formed primarily to develop and propagate best practice and formal quality standards amongst operational forensic science providers, promote little interaction with Universities other than that already undertaken by individual member institutions. We strongly support the development of international academic networks in forensic science, extending beyond the UK-based Forensic Institute Research Network (FIRN).

King's has independently developed an international network of collaborations, which include:

- Institute of Legal Medicine, Universidade de Santiago de Compostela, Spain;
- Ecole des Sciences Criminelles, University of Lausanne, Switzerland;
- Centre of Forensic Services, Ontario Ministry of Community Safety and Correctional Services, Canada;
- Department of Forensic Research, Institute of Environmental Science and Research (ESR), New-Zealand;
- Australian Centre for Research on Separation Science, University of Tasmania, Australia;
- Computer Forensics Research Group, Hong-Kong University, China;
- Hong-Kong Customs and Excise Digital Forensics Laboratory, China;

- Institute for Infocom Research, Singapore.

6. **Are there any other issues relevant to our terms of reference that you wish to comment upon ?**

   Forensic science research and development currently stands at a cross-roads. Only with improved support for leading-edge, multi-disciplinary research, can the full value that forensic science is capable of adding to the police, CJS and the public be both realised and demonstrated clearly.
   To enable leading Universities, such as King's, to make a continued contribution to maintaining and developing the UK's forensic science research capability, we wish to highlight the following as priority areas for Government support:

   - Multi-disciplinary research to gain greater understanding of the societal context in which forensic science is applied;
   - Research to address critical areas of UK forensic science capability that are being eroded (e.g. toxicology);
   - Funding to develop and/or exploit technologies to deliver efficiency savings for forensic science providers and the police;
   - Dedicated calls within existing funding schemes (such as the Technology Strategy Board's newly de-restricted KTP scheme) to enable small, emerging UK forensic science providers to initiate company-focussed research partnerships with Universities;
   - Specific doctoral training and early career awards to support the ongoing development of forensic science researchers and, hence, research capability in the UK.

   Such support will enable Universities, such as King's, and their research partners to work together to maximise the benefits of forensic science in reducing the cost and public impact of crime in the UK.

Further information on forensic science research at King's College London, to support and expand the answers given above, can be found at King's College London - Forensic Science

LANCASTER UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Dr David Lucy in Our Maths Department applies of statistical methods to the evaluation of forensic evidence, and the epistemological aspects of forensic evidence. He undertakes research and consultations for the Procurator Fiscals Office, the Crown Prosecution Service, the Home Office, Her Majesty's Customs and Excise, and Forensic science laboratories and police forces throughout the UK.

Our Psychology Department have expertise in Security screening, Anomaly detection and investigation, Investigative decision-making

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Our computing departments works closely with forces and the MPIA on childrens susceptibility in social networking sites on the web.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Mobile phone software to help keep kids safe

Dr James Walkerdine of Isis Forensics image of courtesy of BBC Online

Children who use social media on their mobile phones can now check their friends really are who they say they are, thanks to new mobile phone software.

The software, which is called Child Defence, enables kids to scan webchat on their mobile to check the age of people they are messaging – potentially protecting them from being groomed by adults posing as children online. Whereas most child protection software will monitor a kid’s online activity and be controlled by the parents, this new software empowers kids to protect themselves.

Researchers at Isis Forensics, a Lancaster University spin out company based in InfoLab21, have been developing the tool in consultation with children and parents in the North West, specifically for use on mobile phones. From Facebook to SMS, recent years have seen a major social networking boom on the internet and children are increasingly accessing these networks

using mobile devices such as mobile phones and iPads.

These developments offer huge opportunities to young people but also pose risks. Predators on the internet can abuse social networks, assuming different identities to target vulnerable children and groom them for abuse – both online and in the real world.The software uses the latest advances in language analysis technology to identify language quirks peculiar to different age groups. It can also link in with websites such as Facebook and Twitter, allowing children to scan chat text from their site. It enables children to build up profiles of individuals who they are chatting to online.

Previously, such analysis would have to be done on powerful servers – but because the software has been specifically designed to work on mobile phones, young people and their parents can scan text themselves. This means that personal data does not have to be sent to a third party server for analysis.
Initial evaluation found that the software used on Child Defence was at least as good at determining if an adult is masquerading as a child as the server-based alternatives, with it correctly identifying all the masquerading adults in a recent trial. The software is currently undergoing final testing before being made freely available as iPhone, Google and Nokia phone apps.

James Walkerdine of Isis Forensics said: “Nothing can take the place of education and parental supervision when it comes to keeping children safe online. But with more and more young people accessing the web on mobile devices away from home or in the privacy of their rooms we think it is important to give children as many tools as possible to protect them from harm.

“Our research shows that children find it very difficult to spot adults posing as children on social networks. This software improves children’s chances of working out that something isn’t right. Using state of the art language analysis software it gives children a powerful tool which can help them work out who they are really talking to online. “Parents in our focus groups told us they would much prefer to see software solutions that empowered and educated their children to help them protect themselves.”

Steve Riches, Director of InfoLab21’s Knowledge Business Centre said: “The internet plays an ever-increasing part in our daily lives and it is essential that children are safe to realise its full benefit. Child Defence has the full support of the KBC team and is a great example of the social impact that technology can have. We must give full credit to James and his team for providing the mechanism to both empower children, but more significantly help to eliminate the potential threat of predatory forces that use the internet to exploit one of the most vulnerable groups in our community”.

Work on the mobile phone software was carried out as part of a project co-funded by the Northwest Regional Development Agency.
To see a video of the software http://www.isis-forensics.com/child_defence_app.swf <http://www.isis-forensics.com/child_defence_app.swf> (Flash required)

UNIVERSITY OF LINCOLN

I have been involved with UK Police Forensics for over eight years since being asked, initially by Lincolnshire Police, to develop a robust system for the remote transmission of fingerprint lifts direct from crime scene to bureau. Supported by Home Office, Police Standards Unit. System in use by 75% of UK Forces and assisted in reducing average time-to-ident from 5 days to 2 hours. Further work funded through EPSRC on automatic footwear recognition for custody suites. Founded Immersive Forensics Ltd to take forward integrated systems that encompass the entire forensic workflow from CSI realtime tasking through evidence gathering, calibration, analysis, and submission to audited reporting. Currently system being piloted for planned East Midlands Regionalisation Programme. Overall aim is to provide improved forensics provision in the light of budgetary restrictions, changes in operational practice and larger operational regions – *Forensics without Geography.* Over 70% of volume crime cases can be progressed with digitised image evidence only, and process modelling suggests a staffing reduction of over 30% is feasible while permitting an improved service provision. The overall approach is to support rather than replace multi-skilled forensic experts through usercentric system design.

Answers to Your Numbered Questions

1 What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

At University level, we will continue to develop advanced image processing and datamining techniques that meet identified forensic needs – for example, unwrapping of fingerprint marks from curved surfaces (architraves, bullets, weapons, etc), scaled scene reconstruction and automated scene identification using Google StreetView and other large image/video corpuses.

At commercial level, to develop in partnership with Police and existing sector provider fully integrated and expandable system for the treatment of forensic evidence.

2 What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

We have worked with several forces (in particular Lincolnshire, West Yorkshire and West Midlands), HOSDB, NPIA, ACPO and independent forensic providers.

3 Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

The use of Alida (remote transmission of fingerprint lifts) by over three-quarters of UK Forces and the significant reduction of time-to-ident has been a major success. Highlighted in annual reports from NPIA and others.

Adoption was not straightforward and succeeded through a few champions within Forces and ACPO.

The challenges revolve around the fragmented nature of the UK Police – 43 Forces, and that national bodies such as NPIA and HOSDB are more focused on procurement than being proactive in seeking out new technology or commissioning it. Published strategy documents present overviews of general needs but little follow-through to specifics.

4 What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Home Office and HOSDB do possess funds for research activities, but they are generally not well publicized and there are some issues relating to IP ownership. The UK Research Councils do have a generic theme (Global Uncertainties Programme) that could encompass forensics but is more focused on wider security and disaster prevention issues. The Home Office has proposed topics for EPSRC's Sandpit process but none directly in the forensic arena. The previous EPSRC initiative on Crime Science was very successful and could be revisited. Though attended several meetings that bring together university researchers and representatives from Home Office, Police and other stakeholders; these again suffer from inadequate post-meeting actions.

From the viewpoint of someone who has been closely involved with science support sections in many Forces and associated organisations (Fingerprint Society, HOSDB,etc.), there can be little connection between forensic needs and academic research. The later tends to concentrate on the academically demanding topics rather on methodology and techniques that will find significant practical use.

I would like to propose a more proactive stance on what are the operational issues that affect forensics provision – improving what is already done, meeting unsatisfied needs, etc.

5 What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

Within our own research area, we do possess good individual relationships with centres and experts (e.g., NIST) but the more formal networks have not proved particularly productive.

6 Are there any other issues relevant to our terms of reference that you would wish to comment on?

I feel that I have touched upon some of the issues raised in the scope of your review, but would like to comment on:

The extent, and the ways in which, forensic science practice assesses the relevance of, and accesses, the latest advances in technologies and techniques.

This point was reported on in the OSI Review of Government Science in the Home Office (2007). Of course, policies and practices may have changed but there was at this time a feeling that, in general, the Home Office and the Police were not good at being fully aware of new developments and research.

Submitter details:
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UNIVERSITY OF LINCOLN

Forensic Science Research at University of Lincoln

A separate return has been made by Professor Nigel Allinson, Distinguished Professor of Image Engineering, on Forensic Imaging at the University of Lincoln; the details are not repeated here.
We are also active in a wide range of areas in Forensic Chemistry and Forensic Biology, including: electrochemical sensor development for explosive and drugs detection, soil provenance, analysis of drugs (including legal highs), chemical fingerprint analysis, DNA analysis of populations (e.g. Libyan, Pakistani), DNA recovery from human remains including fire scenes, decomposition processes and insect colonization of burned bodies, identification of cause of death from skeletal remains, glass reflection indices in forensic analysis.

Partnerships

We have active or developing collaborative relationships with Lincolnshire Police and the Home Office Scientific Development Branch.

Exploitation of Research

We have developed a portable easy-to-use system for drug detection, which would be of significant use to police forces, and have taken initial steps towards commercialization. However, market research indicates that this is a small, specialized market and we are therefore investigating using the platform for other market areas. This research would greatly benefit from a specific mechanism to support forensic research exploitation, and we suspect that the key impediment to commercialization (small specialized market) may be common to other potential products of interest to the forensic services.

International Networks

We have strong international links, in the EU and beyond. We have recently established a Marie-Curie ERASMUS MUNDUS M.Sc. in Forensic Science. This is in collaboration with University of Cordoba and Instituto Superior de Ciencias da Saude, Lisbon and provides a platform for joint research. Other collaborators include: University of Granada, Spain; University of Murcia, Spain; University of Pavia, Italy; University of Minas Gerais, Brazil; AVANS University, Netherlands; Ontario Centre of Forensic Science; Canada. We expect to expand this network considerably over the next few years, and regard development of EU funding streams for forensic research as a priority.

Fragmentation of Research and Development Funding

Broadly, we recognise that R&D in Forensic Science suffers from a lack of specific funding streams for its support, and for its development and exploitation. It would benefit greatly from the introduction of networks of excellence, and from some specific ring-fenced funding (e.g. through EPSRC sandpits and/or appropriate TSB programmes).

Submitter details:

Professor Andrew Hunter
Dean for Science, Technology and Engineering

LOUGHBOROUGH UNIVERSITY

Q1) We are currently looking at a range of novel techniques in relation to fingerprint and document analysis. For example we have developed an entirely new print developing technique which appears to be able to image prints from many "difficult" media e.g. fabrics or bullet casings or indeed from metal surfaces from which the print has been washed (via interaction with the minute corrosion signature left behind).

Q2) We currently have funding from DSTL on work looking at obtaining prints from IED fragments, and from the Forensic Science Service looking at a new print development system. In addition we have strong working links with HOSDB and have had previous funding via MOD; we have also worked closely with the Scottish Police Services Authority and through them have run actual crime scene exhibits through our new technique as part of ongoing criminal investigations.

Q3) Many of the key discoveries in fingerprint work have been serendipitous, ours included. Good examples, now part of standard practice, include metal vapour deposition and superglue fuming. If our experience is anything to go by the problems come not with generating police interest, but in finding ways of carrying on to the next level of development. And this primarily means finding funding.

Q4) The one "moral" of our work thus far is that serendipitous results can have a major impact. Yet it is clear that there is a gulf between synthetic chemists' knowledge of forensic requirements and the understanding of the UK's synthetic prowess by forensic practitioners. In other words they don't talk; at recent HOSDB workshops linking forensic scientists in the fingerprint area to academia I was the only synthetic chemist. There is a clear need and opportunity to get both sides talking and to have a more holistic approach.

Q5) As a result of attending the ANZFSS conference last summer we have had negotiations regarding further collaboration with groups in Sydney (academic and police) and Perth. It is hoped that this will bear fruit this coming summer, and in the mean time a joint final year project student in Sydney is being co-supervised by me.

I hope that this feedback proves useful to your review.

Submitter details:
Dr Paul Kelly
Department of Chemistry,
Loughborough University

MANCHESTER METROPOLITAN UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Manchester Metropolitan University has a well-established undergraduate provision in Forensic Science which at present is delivered through the Combined Studies Network, most frequently in combination with Criminology or Psychology. Some of the major areas covered include forensic and analytical chemistry, forensic biology (including DNA analysis and forensic entomology), geographical information systems (GIS), and forensic investigation techniques. The School of Science and the Environment in the Faculty of Science and Engineering provides the main home for Forensic Science teaching for undergraduate students, and research and consultancy to a variety of clients.

The major research and consultancy areas relevant to the forensic sciences covered by the School of Science and the Environment are analytical chemistry, portable electrochemical-based instrumentation for the detection of drugs, composition of pharmaceutically active materials available for abuse, DNA analysis (in conjunction with the School of Healthcare Sciences), forensic entomology, geographical information systems and forensic science investigation. As a multidisciplinary subject, forensic science is also covered by a number of other areas of the University including the School of Computing, Mathematics and Digital Technology (forensic computing and facial recognition and lie detection, use of databases for forensic applications), and the School of Engineering (materials science and weapon detection systems). Forensic consultancy is undertaken within either/both criminal and civil litigation. Additionally, the University also has substantial provision in criminology, law, forensic psychology, and aspects of business such as forensic accountancy which enables holistic approaches to be developed.

The Intelligent Systems Group in the School of Computing, Mathematics and Digital Technology has developed an innovative psychological profiling system (Silent Talker) which has many potential applications in forensic procedures. This has been patented internationally; a spin out company has been formed and has an international profile. In the first instant, it is a lie detector. Secondly it has been shown to detect feelings of guilt. Also it has been shown to be robust in detecting deception by psychopaths. We plan to extend this to measurement of comprehension (pilot study with FHI underway) this has applications in assessing quality of testimony and fitness to stand trial.

There are plans in place to extend our teaching provision to postgraduate students and to increase our existing continuing professional development (CPD) capability which will include the targeting of new staff in this discipline. Both of these will broaden and deepen our research and development capabilities in this area.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Current links exist between organisations associated with security (e.g. airports), as well as investigation and legislative bodies (police forces and the Home Office), and commercial organisations interested in exploiting new technologies (e.g. facial recognition and drug detection systems).

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Current work into the early detection of weapons is being developed into a system of stand off detection. Developments of drug detection and facial recognition systems are being advanced through commercial organisations. For example, there has been great interest in transferring Silent Talker technology into numerous practical applications. There are a number of barriers to this within the polygraph industry, the main problem being the requirement to buy the complete technology leaving no future research role;

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

In some areas, there is a lack of clear directed funding that is not specifically targeted at the forensic science area, often being subsumed within broader research frameworks. Some funding may be available indirectly through non-forensic frameworks where a research area additionally has forensic application. Commercial institutions may be interested to fund commercially applicable research into already identified products or procedures. However, in dealing with a very wide number of agencies, we have found a major barrier to be the desire to buy off the shelf technology rather than support research even when it is well known that no such technology exists.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

There are few specifically targeted international organisations at present. However, we are working with a number of international companies and academic institutions. For example, in developing the Silent Talker technology, we have contact with many agencies and companies including all the major polygraph manufacturers, homeland security (UK and US), border control agencies, the Home Office, the Pentagon and the Chief of Airport Security. This sector relies on personal trust and personal contact. It does not use the normal academic networking procedures.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

As the current situation with UK forensic science capabilities unfolds, new links will need to be formed in order to exploit expertise wherever it is eventually placed. Academic institutions will need to be highly responsive to the changing training needs of the profession. A new approach is required so that research initiatives can be given more support in the early stages of bringing them to market.

MIDDLESEX UNIVERSITY

Questions for researchers

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**
    a. Middlesex University does not run programmes in forensic science and at present, does not conduct research in these domains. It does however have a thriving biomedical science provision and works in a number of areas allied to forensic science including Criminology and Forensic Psychology.
2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?**
    a. We have no existing relationships with forensic science providers but several existing partnerships with Police Forces, Constabularies, Services and the NPIA. These are at borough command, London wide and national levels. Most such relationships are based in research and knowledge transfer in the domains of: Homicide Detection; Serious Sexual Violence, Rape and Multiple Perpetrator Rape; Serious Group Offending; *Prevent* Strategy; Hate Crimes; Community Engagement; Community Safety including research into 6 BOCUs of East London and West Essex relating to victim, offender and location; Governance and ethics. We have also conducted research for specific cases and appeals such as assessing the reliability of statements produced pre PACE, 1984 and the PEACE model of investigative interviewing.
3. **Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?**
    a. The MA in Public Protection; MA in Critical Incident Management; MA in Crime and Crime Management and PG Certificate in Homicide and Serious Risk Management are all examples of where practitioner and research knowledge was drawn on, in collaboration, to produce innovative teaching tailored to professional development. For example, the MA in Critical Incident Management was specifically focussed to ensure that the final product directly enhanced the MPS Service provision.
    b. Although none of these are exclusively concerned with Forensic Science, there are elements of each programme within the remit of this review.
4. **What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?**

a. As with any applied discipline, the importance now placed on the impact of research could be the advantage of work concentrating on improving, refining and applying forensic scientific knowledge. However, concerns about the loss of “blue skies” research may also be particularly pertinent here. The effect of loss of expertise with disbanding of groups such as Sapphire and the NPIA, will also mean that opportunities for knowledge transfer and even basic recognition of the potential utility of research to a forensic science application, may be missed.

5. **What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?**
    a. We cannot comment on networks purely devoted to forensic science. However, we would draw attention to some of the practitioner networks and academic conferences within policing, criminology, criminal justice and forensic psychology where users and commissioners of forensic sciences would be present These might include the European Association of Psychology and Law.
6. **Are there any other issues relevant to our terms of reference that you would wish to comment on?**
    a. We believe it to have been a mistake not to include the terms of reference and commissioning of forensic science services within this review. When the Forensic Science Service was initially moved to an independent agency, within an essentially unregulated market, concerns were raised as to the potential for miscarriages of justice. The office of the Forensic Regulator has been established partly to allay such concerns. However, with the abolition of the Forensic Science Service and a move to entirely commissioned services on a case by case basis, there is again potential for evidence to be miss interpreted or simply not considered, leading not just to wrongful convictions but also to lines of investigation being dropped and potential wrongful acquittals. In essence, this means that with shrinking budgets, there will be a reduction in the numbers of successful police homicide investigations that identify a suspect from the current high current targets (97%).
    b. Relatedly, we believe that the fundamental changes to the organisation and teaching of university programmes, will lead to specialist programmes or modules in areas such as mycology or entomology, etc. becoming ever rarer. Thus, both those entering training for forensic science directly and those later joining as experts, could be drawn from an ever narrower pool of expertise. By ignoring research conducted into governance of forensic science, commissioning of services, decision making within criminal justice, routes to initial qualification and maintenance of continued professional development, this review will not address some of the fundamental concerns about the

efficacy, reliability and utility of forensic science provision to the police and court services.

Again, we thank you for the opportunity to contribute to this review.

Submitters' details:
Dr Peter Kennison
David Little
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Middlesex University

NORTHUMBRIA UNIVERSITY

Review of research and development in forensic science
Response on behalf of members of Northumbria University Centre for Forensic Science

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Northumbria University Centre for Forensic Science is a newly established Centre and its complete complement of full-time staff came into post in October 2010. Its members have the following research experience:

Both Chris Maguire[1-2] and Martin Evison[3-4] have research experience in low template DNA analysis from a variety of sources using nuclear and mitochondrial DNA targets; and have experience in the measurement of contamination in low template DNA analysis.

Maguire is an acknowledged international expert in familial DNA searching[5-6] and relationship analysis in support of the identification of missing persons and victims of mass fatality incidents. He has also acted as a consultant to the ACPO UK DVI team, the Foreign and Commonwealth Office, the Forensic Science Service and state and federal police forces in the USA and Canada.

Evison has a research record in population genetics, including that of forensic DNA markers[7-8].

Both Maguire[9] and Evison are interested in Disaster Victim Identification. Maguire has participated in a large number of international investigations and deployments. Evison has also participated in human rights related international deployments, as well as an international partnership in forensic human identification (DNA and forensic anthropology) in Brazil[10-11].

Maguire is interested in developing computer applications to generate databases of life-like forensic STR profiles for use in research in forensic genetics, forensic familial DNA searching and Disaster Victim Identification. He is also interested computer applications in footwear mark analysis and other applications in forensic science.

Evison has led substantial research into forensic facial comparison (alternatives to 'facial mapping' and so on), which includes 2D and 3D image analysis[12-15]. He has also conducted research in forensic facial identification from the skull using computer-based approaches supported by further research in craniofacial measurement from MRI[16].

Evison presently combines two strands of research—in facial biometrics and genetics—in a genome wide association study in face shape in 3D.

Robin Williams, Tim Wilson and Victor Toom are—with Maguire—interested in the measurement of value and impact of business models in forensic science service delivery. Williams, together with Jim Fraser (Strathclyde) edited the recently published *Handbook of Forensic Science* (Willan)[17] which surveys the current condition of forensic science, and its utilisation, in the UK and more broadly. Williams is also currently engaged on a study of the use of forensic science in support of homicide investigations for the Metropolitan Police Service.

Maguire has also conducted research into police requirements of forensic science and has designed academically rigorous tools to monitor 'customer satisfaction'. This work is being extended in a current research proposal which has been submitted in response to a Canadian Government request for proposal.

Williams, Wilson and Toom are interested in this and other substantive issues in policy, law and ethics in forensic science, including the practical and ethical connotations of forensic bioinformation; and legislative and human rights issues.

Williams was a member of the Nuffield Council on Bioethics working party which wrote 'The Forensic Use of Bioinformation: Ethical Issues'[18] and together with Wilson and Carole McCartney (Leeds) wrote a more recent report published by the Nuffield Council on the *Future of Forensic Bioinformation*[19]. Wilson and Williams held an International Symposium on Forensic Pathology at Durham University in 2009, and Williams (with Barbara Prainsack (Kings College London) recently organised an international workshop on the Transnational Exchange of Bioinformation. Williams's work has been funded by the Home Office, the Wellcome Trust (with Wilson) and the Nuffield Foundation

Wilson's research and experience is in the interface between the forensic sciences, medicine, public health and broader applications of forensic bioinformation such as immigration control. This ranges from the differences and similarities of epistemological claims within this broad area to specific issues of international cooperation, professional regulation, public finance and democratic accountability in different disciplinary contexts.

Evison is interested in the theory of forensic science, including the scientific claims of certain specialist methods, and in issues of Courtroom admissibility[20-21].

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Members of the Centre currently benefit from partnerships with:

The Metropolitan Police Service

National Forensic Science Technology Center, Florida, USA

Members of the Centre have benefited from partnerships, sponsorship or letters of support from the following organisations in the past:

ACPO
ACPO DVI Team
Australian Federal Police Forensic and Data Centres
Australian Institute of Judicial Administration
ChemCentre Forensic Science Laboratory (Perth, WA)
Council of Belgian Prosecutors
Dectel
Department of Trade and Industry
Department of Business, Innovation and Skills (Public Sector Research Exploitation Fund)
Departemento de Proteção Social Especial, Ribeirão Preto, Brazil
Europol
Federal Bureau of Investigation
Finmeccanica
Forensic Science Service
Foreign and Commonwealth Office
Government Laboratory, Hong Kong SAR
Home Office
Institute of Environmental and Scientific Research, Auckland, New Zealand
Instituto Médico Legal, Ribeirão Preto, Brazil
Interpol
LGC Forensics
Louisiana State Governor's Office
Medico-legal agencies in Brazil
National Policing Improvement Agency (also formerly PITO, NCF and PSDB)
Northrop Grumman
Office of the Chief Coroner of Ontario
Office of the Deputy Prime Minister (Prescott)
Ontario Centre of Forensic Sciences
Ontario Police College
Ontario Provincial Police Service
Royal Canadian Mounted Police
South Yorkshire Police
Technical Support Working Group
Toronto Police Service
West Australian Police Forensic Division
West Australian Department of Mines and Petroleum (Investigative Services Unit)

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Members of the Centre have participated in the following successful translations of research into practice:

Maguire has, on a number of occasions, led the translation of DNA profiling research into operational forensic science; from the inception of the technique into forensic science in the 1980's to the development and deployment of familial search techniques. In addition he has led the development and commercialisation of DNA Expert System software (interpretation, databases and relationship analysis; which was supported by grants from the Public Sector Exploitation Fund (2004 and 2006).

Members of the Centre have participated in the following translations of research into practice that have been difficult or problematic:

Evison led a large inter-disciplinary two-year research programme investigating computer aided forensic facial comparison. This has yielded a book and two peer-reviewed publications, with two further peer-reviewed publications under consideration. The research is underpinned by the largest database of 3D facial images ever collected. It was anticipated to lead to a desktop application tool. While such an application may yet eventuate, it was clear from the research that a scientifically valid model for facial comparison (identification is a misnomer) based on a 'frequentist' model like DNA profiling is a huge undertaking. From this Evison learned:

RCUK and Home Office funding is very hard to secure—its 'spoken for'Some academic collaborators took the money and did what they liked with it It was necessary to cancel sub-contracts of underperforming academic collaborators

Research assistants based on short fixed-term contracts lose interest at the end. Existing practitioners using, at best, protoscientific models don't welcome change. Existing practitioners act as gatekeepers by influencing policy for better and worse

Possibly in a similar vein work by Wilson and Williams (published as *The Future of Forensic Bioinformation,* Nuffield Foundation, 2010) anticipated several of the key changes in Government policy on the forensic use of DNA, as indicated by the recently published Freedoms Bill 2011. This was assisted greatly by genuine engagement (under the Chatham House Rule) by colleagues from the Home Office, ACPO and NPIA in the presence of participants from civil society (e.g. Liberty and Genewatch) and academics from a network of universities. The main difficulties were:

Lack of clear Home Office forensic science policy as a reference point for discussion

Reluctance of police bodies to share in-house research and casework reviews
Defensiveness with regard to challenges to orthodox views

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

We identify the following opportunities:

Opening up of the forensic science research environment following the closure of the FSS
Commercial partnership
An opportunity to promote forensic science research academic partnerships
An opportunity to radically restructure research on a peer-reviewed competitive model
Opportunities to develop work measuring the utility of forensic science applications within criminal investigations

We identify the following barriers:

Uncertain research and funding structure following the closure of the FSS. I think we should highlight the value of funding the US Govt make available for forensic science research and Knowledge Transfer acticvities in addition to the $200million per annum (for 5 years) made available by President's Initiative.

Also new Bill for creation of an Office of Forensic Science to administer forensic science Home Office forensic science research funding is opaque and uncompetitive Home Office research funding is resistant to academic participation and peer review. Proprietorialism in research—'this work belongs to us' and 'this money belongs to us'
RCUK not really funding forensic science research, but saying they do
A command economy in Home Office research, rather than competition and peer-review
A Home Office—RCUK gap, where research is not considered fundable by either
A Home Office—RCUK gap, with no effective cooperation in forensic science research
People 'working in silos'—lack of open communication of research activity
Failure to fully capitalise on and nurture academic partnership
Failure to capitalise on the potential of undergraduate and postgraduate research
Failure to foster forensic research as peer-science in Universities, RCUK and the country
No mechanism in the command economy to develop or incorporate elite research talent

Academia recruits talented forensic scientists, but the talent does not flow the other way
There is a scarcity of scientists, let alone elite research scientists, at the Home Office/NPIA

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

Members of the Centre have benefited from involvement in several national and international research networks in forensic science and the law's use of science.

Evison was leader of an EPSRC network in human identification science from 2003-2005. This quickly grew from 13 University researchers and 4 professional partner organizations to 25 Universities and 16 professional partner organisations. By the time the network, 'ICARIS', was transferred to another researcher when Evison moved to Canada in 2005 it supported 58 academics and 24 professional partners. It is presently inactive.

Evison was leader of a network funded by SSHRC (Canada) in the law's use of science. This network was an international collaborative network funded following a successful small grant application. It involved 18 academic researchers and 13 professional partner organisations in Australia, Brazil, Canada the UK and the United States. A consequent application for a CAD2.5M major collaborative research award was well rated, but not funded (the top four applications were funded and this was ranked 5th).

Evison was also a collaborator on an international forensic science development project in Brazil funded by the UK Foreign and Commonwealth Office.

Williams is currently collaborating with 20 European Forensic Science, Medico-Legal, Law and Ethics institutes and department on two FP7 applications that are under review: a bid for a Network of Excellence in Forensic Genetics and a bid for a Research Project on Forensic DNA Databasing. Together these two bids total more than Euros11M.

Two major events during research process for *The Future of Forensic Bioinformation* drew on the extensive international contacts within government, criminal justice and academia of Wilson and Williams in the UK, Europe, North America and Asia. These highlighted the lack of co-ordinated scientific and policy development by inter-governmental institutions, scientific bodies, academia and criminal justice agencies. This is illustrated in the publication by reference to problems arising from the increasingly rapid technological obsolescence of DNA multiplex and the risks of false matches/eliminations from the interconnectivity of automatic fingerprint identification systems.

The outcome of these partnerships has been funded research and research publications, prototypic applications and capacity enhancement. Networks developed for one purpose are often picked up by different members on an *ad hoc* basis for others, and have a wider benefit than is immediately apparent. There is, nevertheless, an issue of sustainability when funding ends or a leader moves on.

There is also the general issue of how networks are ultimately beneficial given that the Home Office funds HOSDB, NPIA and FSS, and RCUK doesn't really fund forensic science. Very often the researchers are left to identify other sources for their research than the bodies one would anticipate would support them.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

These questions seem to address only 3 and 4 the terms of terms of reference. We are not well placed to answer item 1.

We are interested in the implications of item 2, however. As researchers, we may be well placed to know of and anticipate the 'latest advances in technologies and techniques' in a way that 'closeted' forensic practice may not. As researchers, we may wonder why we do not hear more or enjoy more dialogue and collaboration with practitioners. Furthermore, given that there are numerous researchers in the University system with case experience—some of them quite substantial case experience—and have been or indeed still are forensic practitioners, we wonder why this distinction is so manifest in your review.

In addressing 'scale, scope and impact' there is a fundamental dimension of organisation. We ask whether a top-down controlling model for research, especially one that is rather opaque and proprietorial, is likely to yield the best return. We note that both the US National Research Council report and a number of quite independent submissions to the recent House of Commons Science and Technology Committee review suggest the establishment of a national institute or similar structure to open up research in forensic science and medicine to a peer-reviewed competitive academic model. If carefully constituted, such a body could do much to support networks of academics and practitioners, broker research funds in a transparent peer-reviewed and competitive way, incorporate regulation and accreditation, and foster forensic science as a true peer academic research discipline.

We wonder, also, whether a full independent academic review of research and development in forensic science (and forensic medicine) may be essential.

Note: These views are our own views and not necessarily those of our employer

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OPEN UNIVERSITY

Forensic Science Research and Development
In response to your letter, dated 16th February 2011, regarding the review of research and development relevant to Forensic Science, our response to your questions is as follows:

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

At the Open University we have a portfolio of research projects that focus on visual identification evidence, particularly analysis of surveillance footage, facial compositing and eyewitness identification evidence. This includes work on the VIPER (Video Identification Parade Electronic Recording) and EFIT-V (Electronic Facial Identification Technique Version 5) systems.
We also teach a postgraduate course in Computer Forensics and Investigations (M889) and work in digital forensics is part of the wider remit of our research groups which study Computer Security and Privacy (led by Professor Bashar Nuseibeh, see profile: http://www.mcs.open.ac.uk/People/b.a.nuseibeh). Other prominent staff in computer forensics includes Visiting Reader, Professor Peter Sommer (see profile: http://www.mcs.open.ac.uk/People/p.sommer). We have one PhD student doing research in computer forensics relating to a scientific approach to understand malware analysis. This is relevant to the criminal justice system where a defendant claims the Trojan Defense. The supervisors are Mr Blaine Price (see profile: http://www.mcs.open.ac.uk/People/b.a.price) and Dr Arosha Bandara (see profile: http://www.mcs.open.ac.uk/People/a.k.bandara).

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

Research partnerships that we are or have been involved with include:

- National Centre for Scientific Support to Scenes of Crime Investigation
- ACPO Facial Imaging Group
- West Yorkshire Police
- Strathclyde Police
- Greater Manchester Police
- Aspley Ltd
- Visionmetric Ltd
- Thames Valley Police
- Durham Constabulary

Many of our Associate Lecturers on the computer forensics course are current full-time serving police officers. We have one Knowledge Transfer Partnership recently completed with a computer forensics software company (Evidence Talks, Ltd., Principal Investigator: Blaine Price).

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

The following are some of the good examples:

- Development of new PACE (Police And Criminal Evidence Act) Codes of Practice
- Validation of VIPER video parade system
- Development of E-FIT and EFIT-V
- Development of new ACPO guidelines on facial imaging

And the areas of difficulty we identified are:

- Turning knowledge gained from research into facial comparison and mapping into practice guidelines - forensic science techniques used in these areas are not supported by a body of empirical research. Indeed, research has found them to be inaccurate and unreliable, but they still routinely feature in UK courts
- A scientific approach to digital forensics is often lacking with no measures of confidence or error rates as one would expect in a traditional scientific discipline, especially as applied to malware where it is lacking.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

The main barriers are that forensic science often falls between the remits of UK research councils, and is also seen as the remit of the Home Office, who do not actually offer a programme of independent researcher driven funding. And digital forensics research seems to be poorly funded because it falls between two stools: it is more applied than traditional computer science so seems to receive less attention from funding councils but other than small pockets there is little interest in industry in funding research because of the fierce protection of intellectual property.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

SARMAC (Society for Applied Research in Memory and Cognition) and EAPL (European Association of Psychology and Law) are the key international organisations that the Open University are involved with. In digital forensics, the Open University participates in largely ad-hoc informal groups such as the popular Digital Detectives group or the First Forensic Forum (F3). The Open University has also participated in the Black Hat conference, a major commercially oriented event

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

Increased funding and collaboration, especially digital forensics research related to cyber crime, is going to be important for the economy given the scale and increasing sophistication of computer based cyber attacks.

Submitter details:
Dr. Malcolm Cross
Director of Research & Enterprise

DEPARTMENT OF STATISTICS, UNIVERSITY OF OXFORD

Thank you for your request concerning the above. Below are some replies to your questions with special reference to the Department of Statistics at the University of Oxford.

1. There are two specific relevant research activities in the Department:
   a) General research in statistical genetics, championed by Professor Peter Donnelly and others, which has fundamental bearings on issues of forensic identification through the increasing technical ability for detailed analysis of DNA molecules as well as a rapidly growing scientific understanding of the human genome;
   b) Specific research in application of graphical models and probabilistic expert systems to issues of combining complex items of forensic evidence to a coherent and more global picture, specifically, for example, concerning the analysis of DNA evidence. This line of research is championed by Professor Steffen Lauritzen
2. There are no specific formal arrangements of collaboration between police forces and the Department, although there has been previous and current contacts on scientific issues and specific cases. Contacts have involved forensic science institutions in the UK, in Denmark, in Italy, and most recently the Netherlands, as well as other academic institutions in the UK and abroad;

At this point I have no further comments to the issues raised.

Submitter details:
Steffen Lauritzen
Professor of Statistics
Head of Department
Department of Statistics, University of Oxford

UNIVERSITY OF PORTSMOUTH

1. ***What work relevant to forensic science is being done in your group and what are the opportunities for the future?***

Current work in Forensic Psychology:

- Improving reliability of evidence obtained from eyewitnesses, discriminating between reliable and unreliable eyewitness and development of techniques to increase witness contribution to criminal investigations
- Detecting deception in suspects (including suspected terrorists), witnesses and those committing fraud using verbal and non-verbal behaviour
- Development of the Self Administered Interview Recall Tool
- How suggestibility affects eyewitness testimony and identification
- Evaluating the performance of child and vulnerable witnesses
- Assessing the vulnerability of professional investigators to cognitive biases such as confirmation bias
- Evaluating decision-making and other cognitive processes in professional firearms teams
- Assessing the impact of stress, exertion and cognitive load on police decision making
- Detection of counterfeit currency
- How display characteristics of X-ray images of luggage affect people's ability to identify weapons in the luggage
- How display characteristics of CCTV footage affect the ability of observers to detect that the people being observed are the same or change during an event
- Creating training methods for Facial Image Comparison
- Decision-making in burglars inside the property – devising crime prevention strategies
- Understanding processes linking life events to homicide or sexual offending
- Identifying biases in juror and jury decision making with a view to developing aids and procedures to enhance jury decision making re future Jury Reform

Current work in Forensic Biology:

- Post-mortem facial reconstruction from skulls of Middle Eastern and South Asian origin
- Y chromosome Short Tandem Repeat markers in Iranian and Afghani ethnic groups
- Refined estimates of Post-Mortem Interval obtained using blowfly pupae
- DNA-typing of victims based on maggot gut contents
- Improved recovery of DNA from difficult crime scene sources

2. ***What previous and current research partnerships do you have with forensic science providers, police forces, the national police improvement agency etc.?***

Current:

UK MoD; US FBI; US Department of Homeland Security; Nuffield Foundation; EPSRC; ESRC; Innovation Group; British Academy; Home Office Scientific Development Branch; Police forces (Metropolitan, Northern Ireland, Greater Manchester, British Transport, Hampshire, Sussex, Kent, Tayside); NPIA/ACPO; Finnish, Dutch, Norwegian and South Korean Police.

Previous:

Home Office Research and Statistics Directorate; Prison Service HQ; Scottish Prison Service.

3. ***Can you give good examples in the forensic science field of translation of research into practice and also any examples where this has been difficult or problematic?***

- The Self-Administered Interview (memory-enhancing) Recall Tool is currently being field trialled by several UK and international police forces and has been officially adopted as a "force form" by Greater Manchester Police.
- Research on lie detection is now used by Departments of Defence and Homeland Security in the UK and US and by insurance companies in the UK.

4. ***What do you see as the opportunities for and the barriers to the funding of research relevant to forensic science?***

- Research in this area is very applied, has high impact and excellent end-user engagement. The applied nature of the research allows the exploitation of diverse funding streams, including private industry. The rewards, both financial and in terms of improved security and justice, are substantial. Science with real world applications is attractive to the public and potential students.
- Opportunities for research funding are predominantly from short term Knowledge Transfer activities or from charities such as the Royal Society or the Leverhulme Trust. Collaborations with police services and other partners, are short term and advisory in nature, making sustained investigation of specific forensic problem areas difficult.
- Cuts in public spending, including research councils, may lead to a loss of expertise to other, more enlightened, parts of the world.
- Difficult for academics to identify the contacts in forensic settings, no central forum to identify relevant points of contact
- Access to organisations can be problematic without 'champions' for science or evidence based innovation within those organisations

5. ***What are the important international networks and how useful are they?***

   - Society of Applied Research in Memory and Cognition (SARMAC): international network of researchers looking at memory and decision making in applied (often psych-law) settings. The Society holds bi-annual conferences, and a new associated journal is to be released this year.
   - European consortium in Psychological Research of Deception Detection (EPRODD): a consortium of eight Universities in six countries (Belgium, Germany, Israel, the Netherlands, Sweden, United Kingdom)
   - American Psychology-Law Society (APLS) and European Association of Psychology and Law (EAPL): both of these bodies hold conferences showcasing research relevant to the application of psychology to forensic settings.
   - SARMAC, EAPL, & APLS provide valuable networking opportunities, and foster solid research communities.
   - Research collaborations in Australia, Canada, Finland, Germany, the Netherlands, New Zealand, Norway, Sweden, South Korea and the US.
   - European Association of Forensic Entomology, which is generating a set of professional standards.

6. ***Are there any issues relevant to our terms of reference that you would wish to comment?***

UNIVERSITY OF PORTSMOUTH

Science and Technology Information Network (SATIN)

The Science and Technology Information Network (SATIN) project is researching knowledge sharing for forensic practitioners and affiliated organisations. The aim is to review the information requirements of forensic practitioners and provide a web based network to share and coordinate research between academic institutions, practitioners and associated stakeholders. The focus is on how new science and technology is used, ascertaining user requirement and technological capability resulting in good practice models shared through a web based network. This will establish agreed protocols and develop an understanding of potential capability, enhancing technological performance through user based methodologies. The outcome of this research will improve the identification, capture and dissemination of forensic science evidence from the crime scene through developing an enhanced understanding of the use of new technology along with researching new models of police scientific service delivery in line with contemporary requirements.

Various technologies and scientific processes are intrinsic to delivering crime scene investigation and forensic science services. This project is engaging with users of relevant forensic science technologies to establish the ways in which they are being used and, through further research, it aims to define good practice methods. A corollary of this is looking at the capability and scope of the technology and / or technique. So far sequentially lifting and visualising crime scene marks (fingerprints, footwear marks, etc) within contemporary requirements, technology for three-dimensional visualisation of the crime scene, and methods to extract Deoxyribonucleic acid (DNA) material from crime scene lifting materials is being researched by associated teams. The experimental work and practitioner collaboration is being used to evaluate capability in the operational context, this is augmented by interviews with current users, and engaging with existing peer-reviewed work. Furthermore, the SATIN project web site, including research data and findings from relevant studies, is currently being developed this will present the data and encourage practitioners to engage and comment to help formulate appropriate protocol.

SATIN is a collaborative project between University of Portsmouth, Leicestershire Constabulary Scientific Support Unit and Hampshire Constabulary Scientific Services. Our international collaborators are Dresden Police Forensic Science Unit and we are consulting with BVDA International in the Netherlands. The project is coordinated by Paul Smith (University of Portsmouth), Ken Andrews (Leicestershire Constabulary) and Barbara O'Donoghue (Leicestershire Constabulary). The project team also liaise with the National Police Improvement Agency business change unit and crime scene investigation training team at Harperley Hall, County Durham.

Associated Projects

ForSAware: Researchers are looking at the forensic awareness of frontline police officers and community support officers. The project aims to establish the level of media influence on forensic science knowledge and look at current levels of forensic awareness across different forces. The aim is to identify good practice models to support and enhance the delivery of forensic awareness training to frontline officers.
Researchers: Dr. Paul Smith, Dr. Becky Milne, Jon Cooper

Scientific Service Work Model Enhancement: This is a collaborative research project between Hampshire Constabulary Scientific Support Unit and researchers at the Institute of Criminal Justice Studies at the University of Portsmouth. The aim is to strengthen the collaborative research and teaching relationship between both organisations. The research project is examining the existing scientific support work model and working together to modernise the way scientific services are delivered in Hampshire Constabulary in line with other relevant national and regionalisation strategies. Phase 1 of the project is looking at the processes, procedures, efficiency and effectiveness of the Chemical Treatment Unit. The research strategy proposed can be generic and a similar strategy can be utilised for work model research in other areas.
Researchers: Dr. Paul Smith, Terry Lowe (Scientific Services Manager, Hampshire Constabulary)

Research and Teaching Centre for Chemical Development: This project is in the early stages of discussion. Scientific Services at Hampshire, Hampshire County Council and the University of Portsmouth are proposing to share chemical treatment resources to develop a research and teaching centre which allows support for operational requirements and supports the research and teaching requirements of the three organisations. If the initial venture is successful the notion will be expanded to support other operational forensic science requirements coordinating a collaborative centre between the three organisations.

Researchers: Terry Lowe, Dr. Paul Smith, Glen Taylor (Head of Scientific Services, Hampshire County Council)

Reply to Questions

The response to questions 1 and 2 is outlined above. The overarching objective of this research is collaboration between police, practitioners, stakeholders and researchers. We are building a significant collaborative relationship with local forces and we are in the process of developing a working partnership with Dresden Police Forensic Science Unit.
In response to question 3, the approach used by SATIN is to engage and set up partnerships with practitioners collaboratively researching areas identified of interest and developing project outcomes intrinsic to improving the delivery of forensic science. This approach involves group discussions and developing agreed research streams, appropriate project strategies and a robust review process to ensure the project remains relevant and on schedule. In regards to research funding, the SATIN project was set up through an internal capacity building grant, the work has been running for eighteen months generating articles currently in press which will soon be submitted for peer review. We

are making application for further funding through the social science and physical science research councils. We have a specific international collaboration with the German police and we are expanding the project to look at the comparative models of forensic science provision.

UNIVERSITY OF READING

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

i) We undertake forensic consultancy work in the areas of analysis, sourcing and characterising of materials that are relevant to crime scenes and investigations. One of our staff (Dr Stuart Black) was an expert witness in the 21st July attempted bombings in London using such techniques to help Counter Terrorism Command successfully complete this prosecution. Dr Black has undertaken extensive other consultancy work applying to areas of traditional research (using isotopes, trace elements to source rocks, soils and the methodological approaches) to forensic cases. There is an immense opportunity to continue and expand this 'cross over' science to the forensic science community. For example, using isotopes to source where people were living in the past is an extensive area of research in archaeology and the methodological approaches can be applied to forensic science (and have been successfully on numerous occasions). However, the lack of support for this type of work (from both research councils and the Home office) has meant there have been many missed opportunities (e.g. the creation of appropriate databases for forensic purposes).

ii) In Biological Sciences (Dr Perotti) we are carrying out research in different topics of forensic entomology and acarology. Some of our ongoing projects: **d**eveloping novel techniques to correct ageing of 3rd instar blowfly larvae in wandering stage and pupae; these are main markers used by police investigators for postmortem interval estimations; **p**opulation dynamics of the soil microfauna under carcasses or corpses **t**he human acarofauna; how mites move from one individual to another and how we can make use of this information in forensic settings; **f**orensic acarology in general: mites as markers of time, mites as trace evidence, mites as forensic markers in cases of neglect, mites as markers in illegal trade, imaging techniques to isolate mites, etc. We are the leading force behind the development of forensic acarology.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc?**

i) Dr Black is a member of the 'Natural Justice' team of assessed external experts used by the Forensic Science Service as well

as being approved for use in cases by the NPIA and other bodies (e.g. LGC Forensics). Research undertaken at Reading in SHES has also been supported by the Home Office as part of the Human Provenancing Project (HPP) which was directed by former Chief Inspector Will O'Reilly using Dr Black from the University of Reading, the Forensic Science Service and the Home Office Language analysis team.

ii) Dr Perotti has built successful collaborations in forensic acarology with research labs and forensic service providers in Sweden, Italy, Spain, France, Netherlands, Germany and USA. We are actively interacting with police forces, national (governmental) forensic organizations and international associations (i.e. EAFE, APST, etc) from several European countries, with the exception of UK. Within the UK the situation is different. The imminent closure of the main governmental institution, the Forensic Sciences Service (FSS) is affecting research and development.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

There are many good examples of how basic science research translates into the forensic field. Dr Black has had several co-sponsored projects with forensic-related organisations, for example, Dr Lisa Reid (now working at DSTL, Fort Halstead) undertook a PhD supervised by Drs Black and Almond from University of Reading in conjunction with Dr Bond from Northants Police Force investigating gunshot residue analysis to improve this methodology (Reid et al., 2010). Many other examples exist for this category, for example, ecology and biological research relating to sourcing and tracking of animals has translated through to forensic purposes.

References relevant to work undertaken by Black relating to forensic science:

Reid, L, Chana, K, Bond, JW, Almond, MJ and **Black, S.** (2010). Stubs Versus Swabs? A Comparison of Gunshot Residue Collection Techniques. Journal of Forensic Science, **55**, 753-756

Young Shin, J., O'Connell, T., **Black S.** and Hedges, R. (2004). Differentiating Bone Osteonal turnover rates by density fractionation; validation using the bomb ^{14}C atmospheric pulse. *Radiocarbon*, **46**, 853-861.

Black S. (2004). Nature's Stopwatch. *Hobsons Postgraduate Magazine,* **Science Features 008**, 34-36.

Black, S. (2003). Accurate determination of the post-mortem interval in human skeletal remains. In: Pye K., Croft D. (Eds).*Forensic Geoscience: Principles, Techniques and Applications. Conference Abstracts,* Geological Society of London, 3-4, March, 2003: 14.
Swift, B., Lauder, I., **Black, S.** and Norris, J. (2001). An estimation of the post-mortem interval in human skeletal remains. *Forensic Science International*, **117**, 73-87.

In the case of forensic arcarology Dr Perotti considers there are many cases where arthropods were the only evidence and also complemented other information in many legal inquiries. For forensic acarology, examples: bites of mites (Trombiculidae) were the only robust evidence in a case of rape and homicide; as a result of the analysis of the mite evidence the suspect was convicted to life in prison without parol; several cases involved and involve estimations of time of death using developed population/s of mites on corpses; for details of more cases and the potential of forensic acarology in different legal settings please consult the monographic work of Perotti MA 2009, Forensic Acarology, a special issue of the journal Experimental and Applied Acarology, Vol 49.

4. **What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?**

The key opportunities are for the dissemination of science into the forensic science areas in a more efficient way, for example, the use of new analytical techniques, methodologies for development of new techniques, and ways of using science research. The Home Office should consider setting up a series of ambassadors to champion areas of science for forensic research and also set up regular science share workshops and meetings such that University researchers can inform other areas (Policing, forensic services etc of advances in the areas). The Home Office needs to be able to commission its own research that is not overly focussed on traditional areas of forensic science (e.g. DNA, fingerprints etc).The FBI programme of internships is a good example of how research and forensic science could be integrated further.
The dissolution of the FSS has promoted the creation of many several private providers, companies and/or consultants. Universities and research institutes see very little interest, if at all, in research and development; these companies are mostly concerned about commercial considerations. Our experience in seeking support from the private sector indicates that the private companies expect to access new technology developed by the academy without investing in research. In our area of expertise so far Manlove Forensics (who provides service in forensic biology and ecology) is the only UK service provider with whom we have successfully started research collaborations.

5. **What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?**

Forensic Isotope Ratio Mass Spectrometry network (FIRMS): this is a useful umbrella organisation that sends out quality control samples for assessment etc and organises international conferences on the area of isotopic investigation in forensic science.
Other international links are: The Netherlands Forensic Institute; International Commission for Missing Persons.
In the fields of forensic entomology and acarology:
EAFE, European Association of Forensic Entomologists.
NAFEA, North American Forensic Entomology Association
ENFSI, European Network of Forensic Science Institutes
APST, Animal, Plant and Soil Traces group. An exclusive international group of police investigators from national forensic services (from European countries) with expertise in biological traces and micro-traces. The group will consolidate as an official organization during the next (2nd) meeting, in March 2011. Perrotti is a member of a number of the above.

6. **Are there any other issues relevant to our terms of reference that you would wish to comment on?**

Some areas of traditional academic study have a very specific focus for research council funding (e.g. BBSRC for biological work etc). Forensic-related research work is extremely difficult to get funded as it falls between several stools of the remit of research councils (e.g. NERC, EPSRC and BBSRC), with only the EPSRC taking on the more physical and chemical nature of the work. A stronger focus on key areas, and specific dedicated pots of money for forensic research would be good to see in the future.

Submitter details:
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THE PSYCHOLOGY DEPARTMENT, UNIVERSITY OF ROEHAMPTON

CURRENT ACTIVITIES OF RELEVANCE IN THE PSYCHOLOGY DEPARTMENT UNIVERSITY OF ROEHAMPTON

1. **What work relevant to forensic science is being done in your group/ university and what are the opportunities for the future?**

Within the Psychology Department at the University of Roehampton three members of staff are either HPC Registered Forensic Psychologists or are eligible to be so registered. A number of other staff members undertake Forensic Psychology research

A student has recently completed a PhD entitled:
Psychological Aspects Of Internet Sexual Offending

The Department of Psychology offers a PsychD in Forensic Psychology (Practitioner Doctorate) for Forensic Psychologists who are already eligible to be HPC Registered Forensic Psychologists.

It is anticipated that the PsychD will grow in future years.

Professor Edelmann who directs the Forensic PsychD is on the Editorial Board of the Journal of Criminal Psychology.

Current PsychD Forensic research projects are:
a) Predictors of Recidivism in Sexual Offending
b) Investigating concerns amongst IPP sentenced prisoners: what effect does the sentence have on motivation to change, emotional well-being and prison life?
c) The interplay between risk and protective factors in the prediction of self-harm and suicide within a prison environment
d) An evaluation of the Becoming New Me Adapted Sex Offender Treatment Programme for Intellectually Disabled Sex Offenders
e) Evaluating the effectiveness of community forensic mental health teams: a Northern Ireland perspective
f) Intellectual Disabilities – Policy and Practice within Multi Agency Public Protection Arrangements.
g) The relationship between personality disorder and attrition from offending behaviour programmes.

Other doctoral research of relevance in the Psychology Department is:
a) Role of parenting in anti-social and delinquent behaviour in young people.
b) Callous-unemotional psychopathic traits in childhood and adolescence as predictors for violence in adulthood.
c) The role of callous-unemotional psychopathic traits in the treatment of conduct disorder in children and adolescents.
d) Mental health problems among young people in the prison.

Staff also undertake and publish Forensic Psychology research examples of which are:

Anastassiou-Hadjicharalambous, X. & Essau, C.A. (in press). Violence and abuse in Cyprus. To appear in A. Browne Miller (Ed.), *Violence and abuse in society: Across time and nations.* New York: Praeger-Greenwood Publishing Group.

Biswas, U.N. & Essau, C.A. (in press). Domestic Violence against Women and Girl Child – A Case of India. To appear in A. Browne Miller (Ed.), *Violence and abuse in society: Across time and nations*. New York: Praeger-Greenwood Publishing Group.

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Finkler, L., dos Santos, S.S., Dell'Aglio, D.D., & Essau, C.A. (in press). Violence and abuse in Brazil. To appear in A. Browne Miller (Ed.), *Violence and abuse in society: Across time and nations*. New York: Praeger-Greenwood Publishing Group.

Ishikawa, S., Sasagawa, S., & Essau, C.A. (in press). Child Abuse and Violence in Japan. To appear in A. Browne Miller (Ed.), *Violence and abuse in society: Across time and nations*. New York: Praeger-Greenwood Publishing Group.

Koydemir Ozden, S., Bray, D., & Essau, C.A. (in press). Domestic violence in the UK. To appear in A. Browne Miller (Ed.), *Violence and abuse in society: Across time and nations*. New York: Praeger-Greenwood Publishing Group.

See, C.M & Essau, C.A. (in press). Violence and abuse in Malaysia. To appear in A. Browne Miller (Ed.), *Violence and abuse in society: Across time and nations*. New York: Praeger-Greenwood Publishing Group.

Slade, K. Edelmann, R. J., Worrell, M., & Bray, D. (M ay 2011). The interplay between risk and protective factors in self-harm behaviour in prison.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?**

In relation to the PsychD Forensic Psychology links are established with various sections of Prison Service and the Probation Service.

Professor Robert J. Edelmann who directs the Forensic PsychD works with a number of Police Forces and is listed in the NPIA database.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Professor Edelmann undertakes research and provides psychological support to those working in high demand areas of Forensic Science and Policing.

Professor Essau undertakes research with the prison population in Germany.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Unsure

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

Professor Essau is collaborating with numerous members of The Society for the Scientific Study of Psychopathy, and with numerous experts (mostly in the US, Germany and Australia) in the area of conduct disorder and psychopathic traits in young people.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

No

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SHEFFIELD HALLAM UNIVERSITY

1. Engineering

Prof Smith has a reputation both nationally and internationally as a *Forensic Engineer* and has provided expert witness testimony in a number of high profile forensic criminal and civil investigations. He has strong links with UK's *National Senior Collision Investigators* and has been invited to their annual conference this year to deliver a workshop on Forensic Investigation of Light Bulbs.

He has been instrumental in pioneering the use of Advanced Analytical techniques in the field of Forensic Engineering. For example, he was approached by John Bloomfield, the Coach and Rifle Manager of the England Commonwealth Games Team (1998, 2002 and 2006), who had attended one of his national invited lectures in London on Forensic Engineering, to see if it would be possible to identify the type of bullet that had been fired in a multiple, and high profile, attempted manslaughter case. Identification of the bullet would establish whether the defendant or the police had fired it. This case was the first time that evidence gained using an Environmental Scanning Electron Microscope was allowed.

He has developed a number of courses related to forensic science including the first BSc Forensic Engineering degree in the world in 1998. This was also the first “Forensic” course in the university which has recruited successfully since 1998 and the success of the forensic initiative has led to the development of a number of other SHU-Forensic disciplines including; BSc (Hons) Forensic Analytical Science; MSc Forensic Accounting; MSc Forensic Criminology; MSc Forensic Psychology and MSc Forensic Science.

In 2006 he wrote the *Forensic Investigation of Light Bulb* CPD short course for senior UK Collision Investigators. The course has now been delivered 18 times to 176 delegates from 28 Constabularies. It is frequently described as the “best training course taken by collision investigators in the UK”. He has also written, in close collaboration with *Institute of Traffic Accident Investigators* (ITAI), and has had validated, a Foundation degree with a BSc top-up in *Collision Investigation*. This course was written specifically for practicing UK Constabulary Collision Investigators/Vehicle examiners.

Questions for researchers:

(i) What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

We have carried out a great deal of advanced analytical work (using Scanning Electron Microscopy, Environmental Scanning Electron Microscopy, Infinite Focus Microscopy and Energy Dispersive X-Ray Analysis) to establish and increase the reliability of the evidence presented to establish the on-off status of automotive lamps following road traffic incidents.

In our Materials and Engineering Research Institute (www.shu.ac.uk/meri) we have worked on numerous forensic investigation projects for the police, coroners, CPS and public and private organisations involved in legal cases, and delivered expert witness reports and court appearances. We have a wide

range of analytical and testing equipment which would mirror much of that offered by the FSS (http://www.shu.ac.uk/research/meri/equipment/index.html), combined with significant expertise in most areas of materials. Example investigations are: failure of orthopaedic devices (Legal); examination of failed automotive components (Criminal/Legal); examination of failed medical instrumentation (Coroners); examination of failed rope (Criminal); examination of circuit board components (Criminal); examination of ceramic fragments (MHRA) and examination of dental crowns (Swedish government)

Future opportunities are only limited by lack of funding.

(ii) What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency (NPIA), etc.?

We have strong links with around 15 UK Constabularies and good links with a further 10.

(iii) Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

The Forensic Investigation of Light Bulb CPD short course work is a very meaningful example of genuine translation of research into practice. This started off as a research project the results from which I presented at an invited prestige lecture at the IMECHE HQ in London. In the audience was a senior collision investigator who asked me to carry out an expert witness analysis of a case he was involved with and from there the relationship developed into numerous expert witness consultancies and, of course the CPD course which has been, and continues to be, successful. We also carry out a number of forensic engineering materials investigation expert witness consultancies – ranging from charges of causing death by dangerous driving, to murders and manslaughters. Clearly this is a translation of our excellent materials research into forensic practice.
The web link for the Forensic Investigation of Light Bulbs short course in – http://www.shu.ac.uk/research/meri/lightbulb

(iv) What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Forensic science and forensic engineering are both seen as applied rather than “blue sky” research and is difficult to attract funding. There are opportunities to develop but this would require individual constabularies working more closely together. Currently each constabulary (there are ~40+) operates totally independently. There is an opportunity of SHU becoming the UK centre for Forensic Analysis of metals and materials– e.g. light bulb investigations, any metallic components which are suspected to have caused a collision, weapon analysis, we have a very respectable pedigree in this field.

(v) What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw

to our attention?

We are developing international networks but this is at the embryonic stage.

2. Biomedical Research Centre

Contact: **Prof Nicola Woodroofe**

Questions for researchers:

(i) What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Current work in the Biomedical Research Centre (BMRC) at Sheffield Hallam University is focused on the chemical analysis and imaging of fingermarks using Matrix Assisted Laser Desorption/Ionisation Mass Spectrometry Imaging (MALDI-MSI) and Raman and Surface Enhanced Raman Spectroscopy (SERS). Both MALDI and SERS are emerging, advanced analytical techniques and have both been applied in a novel way to fingermark analysis. Detection and imaging of a variety of endogenous biomolecule classes (including lipids, amino acids, peptides and proteins), and exogenous condom lubricants, along with fingermark ageing studies have resulted in MALDI MSI based publications/papers in preparation with forensic applications[1-4]. The superiority of MALDI MSI technology over the currently applied methods consists of the ability to not only provide an image of the fingermark but also chemical information about the donor, which could be used as intelligence by the police. Additionally, a novel method of sample preparation for MALDI has resulted in a patent application (application filing number 1104003.7) and a submitted publication demonstrating a crime scene process for fingermarks, compatible with later MALDI analysis[5]. SERS has also been used to image fingermarks, with a view to non-destructive *in situ* crime scene analysis[6]. Work in both MALDI and SERS fingermark analysis are continuing.

Future work will be based on recent applications to UK research councils and other funding bodies. These include: (i) detection of bioweapons in biologically contaminated fingermarks and simultaneous retrieval of fingermark ridge pattern image (MALDI MSI based); (ii) development of a contactless device to aid *in situ* fingermark recovery and simultaneous preparation for MALDI MSI analysis; and (iii) non-destructive analysis of unknown substances at crime scenes, e.g. drugs of abuse, body fluids (SERS based).

Additionally work is being undertaken by Dr David Crowther on (i) the use of non-destructive computer-reconstructed microscopic imaging for characterization of fibres (with the Materials and Engineering Research Institute at SHU) and analysis of legal highs by GC-MS, LC-MS-MS and other methods.

In the past, staff in the BMRC have engaged in research into the analysis of drugs of abuse in biological fluids, developing both immunoassay and LC-MS methods for the analysis of amphetamines and the cocaine pyrolysis product, AEME, in collaboration with external companies. We are also employed by companies to synthesize organic chemicals for use in the production of

antibodies, which can then be used for immunoassays for drugs of abuse. We have some experience of working with hair analysis.

Wesley Vernon is Head of Podiatry and Research Lead for Sheffield Primary Care Trust. He is an honorary research fellow at SHU and has Fellowships in the Faculties of Podiatric Medicine and Podiatric Management (Society of Chiropodists and Podiatrists) and the Forensic Science Society. His interests are in forensic and developmental aspects of podiatry. He has authored over 50 publications and presented widely in forensic podiatry. He created and chairs the forensic podiatry sub-committee within the International Association for Identification.

(ii) What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency (NPIA), etc.?

We are members of the Home Office Scientific Development Branch (HOSDB) Fingermark Research Workshop Group, through which a comparison of techniques for fingermark analysis is being undertaken led by Dr Stephen Bleay (Fingerprint and Footwear Group). This work aims to explore a range of modern and innovative analytical technology for possible inclusion within forensic analytical procedures. Dr Bleay has shown interest, funding permitting following HOSDB department rearrangements, in the MALDI MSI work in BMRC in specific areas. Following one of the above mentioned workshops we have been approached by NPIA regarding funding for the condom lubricant research work. NPIA has offered in kind support to one of our recently submitted applications ((ii) mentioned above. A recently retired SOCO is acting as consultant on the same project, as is a North Yorkshire based Chief Inspector seconded to Sheffield Hallam University.

Dr Crowther has previously worked with Derbyshire Constabulary on the use of Hemastix devices for presumptive blood detection at scenes of crime and in a civil forensic context on the use of FTIR microscopy for contaminant identification. Dr Francese has worked in Italy on the detection of viagra™ in so-called natural remedies made in China.

(iii) Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

As mentioned in section 1 we are looking at developing a device to bridge the gap between analysis of ideal fingermark samples in the laboratory and current crime scene practice. The device will make use of the sample preparation method (patent application filing number as above) we have developed to allow fingermarks to be enhanced, lifted, recorded and subsequently analysed using MALDI-MSI. Once this process flow has been demonstrated, operational trials will be necessary. This will be one of the major difficulties for many researchers. Access to operational forensic scientists and real or realistic simulated casework is problematic. For example, a system for accessing a sample bank of materials for analysis is not available in the same way that a tissue bank is for biomedical research. Furthermore, ethical approval for collecting the types of samples required is also problematic.

Funding for this type of work will be discussed in section 4.

In the hemastix example above, no DNA hits were being made on the spots which showed positive for blood. This was due simply to a mismatch in sensitivity, with Hemastix being much more sensitive than the previous LMG or K-M methods. Dr Crowther recommended a simple dilution to match the sensitivity.

(iv) What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

The main obstacle in gaining funding for forensic research is that it does not fall completely into the remit of any one of the UK research councils and, generally, the perception is that it is of less interest to both research councils and other funding bodies than more traditional areas of research. This is despite the fact that research in forensic science often generates considerable public interest (as demonstrated by recent press interest around the fingermark research that we have published from Francese and Wolstenholme at SHU) and can have a great impact on society and, therefore, impact in the sense used by the research councils and REF. An additional barrier to funding by the research councils is that forensic journals tend to have lower impact factors than other journals with overlapping interest e.g. technique based publications. Publishing in forensic journals will consequently be viewed less favorably for research council applications.

We have been approached by a US agency working for the FBI and a MALDI MSI manufacturer for three way collaboration on developing operational fingermark analysis protocols. Whereas this is crucial for the continuity of our research, it may not be the most viable way as IP protection might prevent dissemination. As mentioned above, the applied nature and potential for impact on society is an important aspect of forensic research and should be attractive to funding bodies.

There is also the distinction between longer term research which extends scientific knowledge (RCUK) and very focused short-term application work, which is favoured by forensic practioners. In the UK this was done largely by the Forensic Science Service, now disbanded.

(v) What are the important international networks and how useful are they? Do you have any specific international collaboration you would wish to draw to our attention?

FP7 is an important international network, however, calls can be very specific and many are not relevant to forensic science.

We have collaboration with Robert Blackledge, a US forensic expert, on the MALDI analysis of condom lubricant contaminated fingermark work and a collaboration with ROAR particles Ltd., now based in Singapore, also using MALDI for fingermark analysis.

The major scientific development groups of the international forensic community are the best way to get new developments into practice. SWGFAST and SWGMAT are relevant to the work at SHU as re ENFSI groups.

(vi) Are there any other issues relevant to our terms of reference that you would wish to comment on?

Further to Terms of Reference 3, there are some UK networks/working groups in selected areas of forensic research. However, these appear to be set up locally rather than by the government agency concerned (or similar) and may not allow/advertise access to all interested parties. There is the perception that each University has their own expertise, which is specialised and there is a lack of academic structure to bring Universities together to undertake forensic research. This results in researchers not being aware of each others existence and meetings being sporadic. More accessible groups would aid in collaborative work and potentially more successful applications for funding.

References

1. Bradshaw R., Wolstenholme R., Blackledge R., Clench MR, Ferguson L., Francese S., A novel MALDI MSI based methodology for the identification of sexual assault suspects. Rapid Commun. Mass Spectrom, 2011, 25, 415–422s

2. Wolstenholme R., Bradshaw R., Clench M.R. and Francese S., *Study of latent fingermarks by matrix-assisted laser desorption/ionisation mass spectrometry imaging of endogenous lipids*. Rapid Commun. Mass Spectrom. 2009; 23: 3031–3039

3. Ferguson L., Wolstenholme R., Wheat J., Flinders B., Carolan Vikki Clench MR, Francese S., *Dermcidin Derived Peptides and Small Proteins detection in Latent* Fingermarks By MALDI MS Profiling, *In preparation for Analytical Biochemistry*

4. Bradshaw R., Wolstenholme R., Ferguson L., Blackledge R., Clench MR., Francese S., *Two stranded approach via MALDI IMS-MSI and Raman spectroscopy for the analysis of fingermarks contaminated by condom lubricants*, i*n preparation for Analytical Chemistry*.

5. L Ferguson, R Bradshaw, R Wolstenholme, M Clench, and S Francese *A novel two step matrix application for the enhancement and imaging of latent fingermarks. Submitted to Analytical Chemistry*

6. Ferguson L, Lozano Diz E, Francese S and Wolstenholme R, Gold Nanoparticles for SERS in Fingermark Identification, Perkin Elmer Nov 2010 *Application note*

3. Hallam Centre for Criminal and Community Justice

Contact: **Prof Malcolm Cowburn**

Activity in this centre is not focused on natural/physical science research so may not be relevant to this enquiry. However it does undertake research which would fall under the OED broader definition of 'forensic' - 'ie pertaining to courts of law, suitable or analogous to pleadings in court, forensic medicine in its relations to law and medical jurisprudence.'

'Forensic Science' is one of the routes in the Forensics Masters programme which is co-ordinated by the Department .

Further details can be found at: http://www.shu.ac.uk/prospectus/course/220/

Submitter Details:

Prof Alan Smith (Professor of Forensic Engineering)

SOUTHAMPTON UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

One research group in Southampton University, headed by Professor Tom Brown, is carrying out research to establish new rapid methods of analysing human DNA (DNA profiling) at the Scene of Crimes and in Custody Suites.[1-3] The aim of this research is to be able to quickly match the DNA profiles of individuals with DNA samples found at crime scenes without the need to send the samples to specialist laboratories with the concomitant severe delays in obtaining results. The successful implementation of the new methodologies should be a strong deterrent to crime. Much of this work is being carried out in collaboration with the Laboratory of the Government Chemist (LGC). It also involves an SME situated at Southampton University (ATDBio Ltd).

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

The above research group has also collaborated in the past with the Forensic Science Service (FSS) in a project funded by EPSRC.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

The above research into rapid human DNA profiling is patented and is close to the point of being commercialised by LGC.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Although popular amongst the general public, Forensic research in the DNA field is less fashionable than research in the closely related genomics field. In the current difficult funding climate special initiatives will be necessary to ensure that research in Forensic science is adequately funded. Standard research grant applications in this field are rarely successful.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

No specific response, but recently we tried to secure EU-funding for a forensic research project in the field of DNA profiling. Despite the application being co-written by several major players in the field it was not funded.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

No, except to say that the UK (Alec Jeffreys) pioneered the field of human DNA profiling for forensic applications and the Forensic Science Service in Birmingham (FSS) led the world in developing the technology. Despite this, most commercial exploitation has been carried out by US companies. This is at least partly because the level of investment funding available in the USA is much greater than in the UK.

1. D. J. French, R. L. Howard, N. Gale, T. Brown, D. G. McDowell and P. G. Debenham, *Forens. Sci. Int. Genetics*, 2008, **2**, 333-339.
2. D. K. Corrigan, N. Gale, T. Brown and P. N. Bartlett, *Angew. Chem. Int. Edit.*, 2010, **49**, 5917-5920.
3. N. Gale, D. J. French, R. L. Howard, D. G. McDowell, P. G. Debenham and T. Brown, *Org. Biomol. Chem.*, 2008, **6**, 4553-4559.

STAFFORDSHIRE UNIVERSITY

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

Staffordshire University undertakes research into traditional Forensic Science areas including forensic computing.
The University is active in research and development relevant to forensic science [1]. Understanding the requirements of the industry, as informed by national policy and strategy documents (e.g. Science and Innovation in the Police Service 2010-13 [2]), has served to help align staff expertise and research interests with innovation and R&D requirements.

Research is currently undertaken in the area of forensic analytical chemistry; polarography is being used to analyse heavy metals present in heroin to investigate if information can be used to identify the geographical origin and gas chromatography is being used to explore the potential evidential value of perfumes, antiperspirants and deodorants from crime scenes.
There is research seeking to standardise methodologies for fingerprint research. This includes standardising the deposition process and developing proficiency tests for fingermark assessment. Similarly, DNA and RNA transfer and persistence are studied.

Research is also conducted around the themed area of burials, with regards taphonomy, decomposition, exhumation and the development of innovative location protocols, in both the UK context and in international mass grave environments. Additionally, the 'Burial Research Group' has facilitated collaborative research which has been recognised by the Home Office Scientific Development Branch (tactical search unit).
Work in the areas of analysing computers, embedded systems, mobile phones, PDAs, Games Consoles, MP3 players, Sky+ boxes and a plethora of different digital storage media, working with Police Forces and Companies in the Industry. We are also undertaking research into a simulator which would allow for Forensic investigation. This work draws on experts in Biometrics, Text Mining, Digital Signatures in Imaging, Im1age Processing, Video Analysis and provide Industry recognised Certification for Forensics. Teaching methodologies for analysis and collection of evidence, and Certification in Industry Standard Tools for Forensic Investigations which include: XRY, ENCASE.

1 1. http://www.staffs.ac.uk/faculties/sciences/research/forensic_science/

2. http://www.npia.police.uk/en/docs/science_and_innovation.pdf

Future opportunities involve applications for European funding, closer liaison with Staffordshire Police and the many smaller forensic providers in the Region. We are discussing opportunities with the Home Office Scientific Development Branch (HOSDB) on aspects of fingerprint research and drug identification.

Other opportunities include: the ability to look into identifying tampered image data distributed over the internet; the development of semantic analysis capability that can work in Chat Rooms to identify the age range of people chatting, to ward off possible criminal offence: watermarking of images extended to digital media to provide tamper detection in the form of a Universal tool;, a Quality Mark accessible by law enforcement cybersecurity.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

The University has links with Staffordshire Police service's Head of Forensics; this relationship has facilitated student engagement on research specific topics. The South Yorkshire canine search unit uses the Crime Scene House facilities and research into dog use, dog accuracy and dog training has been conducted in collaboration with them.

A research partnership with the Forensic Science Society (FSSoc) to develop pedagogically robust assessments for the society's national accreditation system of experts. The 'Burial Research Group' has worked with HOSDB (National Technical Support Unit, Search Support) and is collaborating with colleagues in Canada and The Netherlands. We are developing protocols for the examination of mass graves and are collaborating with organisations and individuals in Poland, Germany and the United States. Colleagues have been involved in the development of the UK Forensic Archaeology Working Group, which has drafted standards and competency guidelines in association with the Home Office.

There are plans in collaboration with the NPIA to use reverse engineering to scan injuries and strengthen the National Injuries Database.
We have an 'expert adviser' to the NPIA Specialist Operations section, in the context of 'Exhumation from Lawful Burial' in criminal enquiries. Research reports are submitted to the Coroners' Section of the Ministry of Justice with recommendations for changes in the approach to currently adopted governmental and ecclesiastic authority protocols; (this is also an example of research translated into practice see question below).

Other partners include Forensic Pathways, (Image and Video Processing for Forensic purposes); Hi-Tech Crime Unit, Staffordshire, West Mercia, who provide links to other EU partners through ACPO, TraceaDebt Company; Staffordshire Police Forensic Dept, Collaboration and 6 week Placements; UK Police Forces who provide links to European Universities and Police Forces across Europe e.g. links to the European Police Office, EUROPOL. Student placement partners include: GCHQ; KPMG, Audit, tax and Advisory; SYNAPTIC SOLUTIONS; CY4OR; Forensic Digital Investigation; Serious Fraud Office; CERN.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

The work conducted concerning the location of clandestine graves, has resulted in developments of the policy and practice of users such as the HOSBD search group. The team are patenting an inexpensive system for collecting and analysing fibres The aim is to allow the intelligence and probative value of this evidence type to be enhanced, allowing it to be applied in volume crime cases in a cost-effective manner. Part of this work is in collaboration with Staffordshire Police and students from Avans University in the Netherlands. Other Proof of Concepts work includes: automated categorisation and intelligent development system for consistency/speed in different UK police forces categorising indecent images; tool for forensically securing running Windows memory by an un-trained first responder; tool for forensic investigation of NavMan satellite navigation units; tool for decoding data from Sony Ericsson-branded Original Design Manufacturer (ODM) phones; However, research relating to digital signatures for example have been impeded by the confidentiality of data which has presented a barrier to the access of databases of information, together with Ethics Issues.

Work with the in-house team on development of MCQ's is a direct translation of pedagogic research into practice for the FSSoc. Working with Staffordshire Police projects involving the development of methodologies for the retrieval of data from i-phones and similar devices and also using algorithms to help match specific features in photographs have been developed. Another project collaborating with law firms and a crown court judge, is working to increase the forensic science knowledge of professionals working in law'.

We have developed solutions for iPhone forensic software, are at present involved in the commercialisation of a Robust Video Analytics and Forensics Prototype to analyse the scene and enable the operator to view key events, also developing with them an on-line Continual Professional Development system, a solution for lawyers with cases involving forensic expert, and are presently in the process of translating our research into the development of better ways to manage knowledge in Security Applications.

The Staffordshire University-led EDULINK externally funded project aims to develop the University of Mauritius and the University of Technology into

centres of excellence in forensic education and training in their respective regions. This will be developed through partnership with local stakeholders such as national forensic science laboratories, police forces and other law enforcement agencies, and the local judiciary.

4. What do you see as the opportunities for and the barriers to, the funding of research relevant to forensic science?

The barriers are perceived as those precluding opportunities to apply for adequate funding for forensic science research. Traditional RC-UK grant awarding bodies infrequently offer funding calls in which forensic science is within the scope of that call; European funding is a similar case. There is also the lack of a 'Unit of Assessment' in the next REF, but there is discussion through the United Kingdom Forensic Science Education Group (on which two members are from Staffordshire University) to address this issue.
Other barriers include: users (Police and Government) being reluctant to engage R & D because they see it as being risky rather than a way to improve things; no cohesive National EU Institution for Knowledge Management Systems that allow sharing of evidence - acquisition to sharing.

The current, ongoing changes in the forensic industry and the limited UK and European grant funding, dictates that innovative, industry-directed research is an important directive to ensure that processes and protocols as well as technology can be created that are fit for purpose for the end-users in the criminal justice system. Directives such as 'Forensic 21', initiated by the NPIA, in partnership with the Association of Chief Police Officers (ACPO), direct a research focus that will integrate and exploit existing and new technologies. We have been responsive to national and local needs as evidenced by research conducted with Staffordshire Police. Staffordshire University is one of a select group of sixteen Universities who hold FSSoc accreditation for their degree courses. This represents a nexus of Universities which belong to the newly created Education and Industry forum for the FSSoc. This forum will provide the opportunity for these universities to liaise and collaborate and apply for funding through national and European sources to offer the forensic industry timely and affordable solutions e.g. geophysicists, biomedical scientists/forensic scientists are working together to gather data on the detection of clandestine graves using geophysical and biochemical/analytical markers in soil.

Other opportunities include: the use of PhD projects to address real world practical problems; possibilities for advancement in Networking, Unified Communications; image and Video Processing, Web Technology; the use of Virtual Reality Serious Games in Training

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

The Forensic Science Society [3] is of benefit to the community as it holds specialist meetings and conferences to share and disseminate policy and good practice as well as research findings.

The European Network of Forensic Science institutes has a positive effect upon the industry for similar reasons. However, academic input to these is extremely limited. This is a barrier to effective research.

The Geoforensics and Information Management for crime Investigation Network – GIMI - [4] has been instrumental in bringing together disparate groups under an aligned umbrella of soil and burial research topics and acts as an outlet for good practice and research collaborative opportunities.

There is an extensive network of 'untapped' financial support and practical work undertaken almost always without the knowledge of the forensic and police domains. There are also Informal networks established by innovators engaging in R & D between Companies, Universities and researchers.

Do you have any specific international collaborations

The Burial Research Group has a collaboration with Professor Shari Forbes, Canada Research Chair in Decomposition Chemistry, University of Ontario Institute of Technology, and Dr. B2.M. de Rooij, Avans University, Breda, The Netherlands and also Dr Lorna Dawson at the Macaulay Land Use Research Institute, Aberdeen, Scotland. This collaboration examines the soil and water leachate associated with clandestine grave detection studies. Another collaboration with Dr Nikolaos Kalantzis, a document examiner from Athens, Greece involves the analysis of inks.

2 3. http://www.forensic-science-society.org.uk/home

4. http://www.macaulay.ac.uk/geoforensic/

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

Consider the establishment of a research fund that is administered by users (e.g. The Home Office or ACPO) of forensic science services.

The importance of encouraging companies to see the benefits of innovation in terms of developing their businesses.

A real need to develop better understanding of the requirements of and opportunities for developing supply chains in innovation.

Need for Communication and Knowledge Management Infrastructure based on the needs of the people doing the job.

UNIVERSITY OF STRATHCLYDE CENTRE FOR FORENSIC SCIENCE

Submission from the University of Strathclyde Centre for Forensic Science

Introduction

We welcome the opportunity to respond to this review. The University of Strathclyde has been engaged in forensic science education, research and practice for the past five decades. The Centre for Forensic Science (CFS) is the first centre of its kind and only UK academic institution who is a member of the European Network of Forensic Science Institutes (ENFSI). It was also a founder member of this ENFSI and is engaged in many ENFSI workings groups. It was also a founder member (and first Chair) of the recently formed ENFSI R&D Committee. Amongst current and past members of CFS staff are a number past presidents of the Forensic Science Society as well current and former editors of the Society's learned journal. CFS is also the lead of the Scottish Institute for Policing Research network with specific responsibility for forensic science.

Our comments are aligned to the specific questions raised in the document.

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).

The level of output and quality of forensic science research is generally low compared to that of other academic disciplines. It is poorly funded by the research councils in the UK and although there are other potential funders. (e.g. Leverhulme Trust) this remains at a comparatively low level. There is apparently no political support at present for forensic science research and no systematic or strategic focus despite the fact that there remain many crucial issues to be explored and understood, for example:

- How valuable in educational terms is a degree in forensic science?
- How good is the evidence base for forensic (and policing) practices?
- Why is police knowledge of forensic science generally poor?
- What contribution does science and technology make to justice?

What risks are currently present in the use of science and technology in the CJS and how can these be managed?

This situation contrasts strongly with the recent developments in the United States following the National Academies of Science Report

The extent, and the ways in which, forensic science practice assesses the relevance of, and accesses, the latest advances in technologies and techniques.

There is a major disconnect between forensic science practice and academia. There is almost no tradition of evidence based practice in the sense that this exists e.g. in medicine. Accessing of new technology is therefore generally ad hoc and unstructured.

The scale and scope of forensic science research undertaken in academia and its links with the forensic science practice.

The links between forensic science practice and academia are generally poor. Most universities that teach (and claim to) carry out forensic research are post 1992 institutions with limited research traditions and experience. Despite this there is much rhetoric about forensic research that does not bear scrutiny. The publication rates of the universities that that teach forensic science (with rare exceptions) are extremely low and many have never published a single peer reviewed paper in a forensic science journal.

What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

We believe we have the largest interdisciplinary forensic research group in the UK which currently consists of 13 PhD students, 3 MPhil students and 4 post doctoral researchers. We also have 40 MSc students who carry out research that leads to publications. The largest research group is lead by Dr Naimh NicDaeid but all academic staff are actively engaged in research to some degree.

Our research areas include: fingerprints and fingerprint enhancement, degraded DNA, DNA profiling and interpretation, wildlife crime and species identification, investigation of heat induced bone trauma, electrochemical

sensors with electrochemiluminescent detection, development of electrochemiluminescent labels, biomarker recognition, conducting polymers, novel chromatographic screening methods for substituted methcathinones, development of semi quantitative field tests for controlled substances, reliability of drug profiling using GCMS, ICPMS and IRMS for methylamphetamine and MDMA, investigation of the synthesis of methylamphetamine from pharmaceutical precursors, advanced chemometric and artificial neural network analysis of complex and multivariate data sets, development of robust analytical methods for the analysis for gel pen inks and pigments, fire scene investigation, arc fault mapping, structural responses to fire, analysis and characterisation of tattoo inks and pigments, effective use of forensic science in the investigation of crime, technology transfer of forensic methodologies, the contribution of science and technology to criminal justice.
We published 20 peer reviewed papers in 2010.

What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

We have active and in many cases formal relationships with a large number of organisations examples of which include: many police forces in the UK, NPIA, HOSDB, Forensic Explosive Laboratory the Forensic Science Service, LGC, Scottish Police Services Authority Forensic Services, State Forensic Science laboratory Dublin, Forensic Science Northern Ireland

Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Please see comments below.

What do you see as the opportunities for and the barriers to, the funding of research relevant to forensic science?

There are many significant barriers to research including:

- Lack of funding. Very few if any of the research councils in the UK will consider funding the type of research that is currently necessary in forensic science.

- Complexity. By definition forensic science is an interdisciplinary enterprise. Productive research requires sophisticated collaborations which are rare and difficult to manage.
- Professional cultures
    - Forensic science. There is very limited tradition of collaborative forensic science research in the UK (and most of the world). Most practitioners are at best ambivalent; some are interested but have little knowledge of research methodologies. A very small number are engaged productively but in an ad hoc manner. The ENFSI R&D committee carried out a survey of all European forensic institutes and only a very small number have active research groups. One institute stated that they did not carry out any R&D!
    - Police. There is very limited tradition of police support for forensic science research in England and Wales. This contrasts significantly with the situation in Scotland where the police service have actively supported and funded SIPR including PhD studentships at the University of Strathclyde (and elsewhere) researching effective use of forensic science in the investigation of crime. Notwithstanding, the maintenance of relationships between researchers and operational organisations is a challenging one requiring a great deal of cooperation and trust given that much of the data involved is sensitive.
- Research focus. Partly as a consequence of the issues raised above the focus of much forensic science research centres on technical areas inside laboratories such as analytical methods. Very little is known about how forensic science is used in the field, how evidence and intelligence is evaluated, communication of expert evidence in the courts, and the value it has in the investigation of crime.

What are the important international networks and how useful are they? Do you have any specific international collaboration you would wish to draw to our attention?

We have many active relationships examples of which include: INTERPOL, United Nations Organisation for Drugs and Crime, Federal Bureau of Investigation, US Drugs Enforcement Agency, many ENFSI institutes, Forensic isotope Ratio Mass Spectrometry Network (FIRMS). These partnerships are extremely useful for identifies areas of research, collaborating on issues of mutual interest.

Are there any other issues relevant to our terms of reference that you would wish to comment on?

We would welcome any opportunity to support the development of research in the UK and internationally.

The references below expand and support of the views expressed above.

References

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UNIVERSITY OF SUNDERLAND

I am very pleased that the Home office has commissioned this review of forensic science research. Since the publication of Forensic Science on Trial in 2005, I have been involved in a number of projects and initiatives focused on: improving academia's understanding of forensic user and provider needs; and facilitating better links between academia and the sector e.g. *the future of forensic & crime scene science* (2005, http://www.fsijournal.org/article/S0379-0738(05)00693-6/abstract), establishment of UK Forensic Science Education Group (2006), and *ACPO future forensics project* 2009. More recently, I have been involved with colleagues in the establishment of a North East Forensic Science Network in collaboration with NPIA and the universities of Northumbria and Teesside. I understand NPIA have forwarded the agreed terms of reference to you.

Whilst these projects have had varied success they have demonstrated clearly the benefits (and untapped potential) of closer working and understanding. In my opinion some of the major inhibitors to further progress stem from: the lack of a suitable forum for forensic science users and providers to come together with academia; the lack of a unit of assessment for forensic science in the REF; the lack of forensic science focus within research council funding and associated calls for projects; together with a narrow view of what forensic science and forensic science research constitutes.

You may have already come across the Future Forensics Report that Ian Shaw and myself compiled for ACPO, if so I hope you have found it of some value. In particular I believe that theme 5 (fostering innovation and supporting identification and delivery...) is of particular relevance and maps out a number of the issues. I have taken the liberty of attaching this document to this email, however some of the key points are set out below.

- The police service need to ensure, as the major customer (on behalf of the CJS and the public) that it takes and supports a longer term view on the use and development of forensic science, and the wider science & technology and resource which supports its use. This requires the police service to be part of the wider identification, evaluation and articulation of needs and priorities. In this respect there are perhaps two main questions to address: how will current and future priority areas for forensic science be identified and how will the ACPO innovation model enable a dynamic view of these challenges and opportunities to be presented to the forensic and academic communities; including engaging with academic and government-led research into this process?

  Currently, research and development in forensic science is undertaken by a range of organisations including universities (UK and overseas), the police, forensic science providers, agencies such as the Home Office Scientific Development Branch and companies that manufacture and supply forensic science technology. To maximise and understand the impact of forensic science (and wider science & technology), both in terms of the science itself and the wider resource base its use provides, the police service needs to ensure that forensic science resource is used to

best effect, which could involve five main strands of research & development being undertaken, monitored and evaluated:

1. ***identifying existing police priorities and, within those, the priorities for forensic science*** (specifically to support innovation) in doing so, there is perhaps a need to identify what the benefit indicators are and their prioritisation against crime types and/or stages in forensic process, i.e. to maximise impact and target areas requiring improvement also need better to understand how best to maximise outcomes related to forensic science and to explore the use of forensic science in relation to other policing activities and priorities, particularly to ensure that the wider potential and use of forensic science is realised. There is also a need to recognise and articulate the challenges arising from new types of crime and new types of evidence, to support the development of technological and non-technological approaches and interventions. Thereby, supporting a much proactive and integrated approach in identifying the role of forensic science in tackling crime.
2. **improving forensic science** – The 2008 Caddy report stated - "we have become aware that there is a desperate need for independent research funding in order to advance the discipline of forensic science ". In particular, around: recognising and evaluating existing research within and outside forensic science. There is a great deal of research currently going on but what is it worth and how can it be harnessed to best effect? Including the wider international dimension. For example, need to identify 'obvious' opportunities and gaps and lack of academic evidence base re some techniques and methodologies e.g. by picking up on emerging issues following law commission, regulator and US paper, specifically in relation to the 'robustness' of some forensic science discipline areas
3. **maximising the contribution of the wider use of science and technology and other resource to support the use and impact of forensic science**, by identifying and evaluating the wider use of science and technology to support the use and impact of forensic science e.g. addressing research needs identified in National CCTV Strategy, Royal Academy of Engineering Report in regard to the use of CCTV (public web-cam)
4. **identifying where forensic science could be used to greater effect** using a multi disciplinary approach e.g. criminologists, ethicists, economists, crime scientists. etc. and expertise, and following the introduction of benefit indicators, both within the forensic process and more widely across policing to maximise the potential for the wider use and impact of forensic science resource
5. **Identifying future priority areas,** potential and challenges for forensic science in context of internal and external drivers and changing landscape

Within this, I believe that a key to universities becoming more involved in forensic science research is to devise (and incentivise e.g. REF) a means for

researchers and expertise outside of university forensic science (mainly teaching) departments to apply their thinking across disciplines. Not just in relation to the fields of science, engineering and technology, to improve detection limits, analytical capabilities etc., but also into other academic areas such as design e.g. ‘designing forensic science in’, such that in the event that a crime is committed the potential for evidence to be recovered that will lead to a detection is maximised. Thereby looking at the potential role of forensic science in crime prevention and reduction as well as detection. Tackling the cause as well as the problem.

At the University of Sunderland we have a number of academic programmes and collaborative research projects linked to Digital Forensics (an often forgotten aspect of forensic work), alongside significant academic expertise and capability across applied sciences, media and design. All of these areas have the potential to be focused on enhancing existing forensic practice further, as well as extending the boundaries of its current use. We will further this, in the first instance, through our engagement with the North East network.

I wish you every success in your work it is well over due, and will, I am sure, be very well received.

Submitter details:
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Deputy Vice Chancellor (Academic)
University of Sunderland

TEESIDE UNIVERSITY

Executive Summary

Teesside University carries out high quality research in a diverse range of areas which includes the development new techniques and methodologies for crime detection and cybercrime. This is linked with broader expertise in policing, organised and cross-border crime as well as fraud and financial crime. We offer a unique combination of high quality applied research, significant specialist practitioner expertise and key relevant infrastructure assets. Teesside University is well placed to work with public and private sectors partners to support the validation and implementation of new techniques in support of best evidence to a criminal or civil investigation and ultimately the courts of law.

Introduction

Teesside University has five Research Institutes which support multi-disciplinary research and provide a focus for research activity. Research in forensic science and the broader crime area is proactively supported across these institutes with particular activities carried out within the Technology Futures Institute (TFI), Digital Futures Institute (DFI) and the Social Futures Institute (SoFI).

1. **What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?**

1.1 Work relevant to Forensic Science

Teesside University has a broad range of academic and practitioner expertise within this area, and strong synergies between research, innovation and teaching. The University acknowledges this expertise, and has invested significantly in terms of staff, resources and facilities in this area.

Within the Technology Futures Institute, the crime and security theme builds on a widely and nationally recognised reputation for expertise in the arena and is concentrated on the development and application of new methodologies and future technologies for the crime and security sector. Specifically, research addresses two major thrusts, public protection and crime detection and resolution. Examples of current work in public protection research include major projects ensuring the safety of food. In crime detection and resolution examples of projects include work on a revolutionary automated spectroscopic scanner for scenes of crime; lab-on-chip for portable chemical and biological analysis at the scene of crime; silica nanoparticles engineered for enhanced fingerprint analysis; improved identification and analysis of fragmented human remains using FT-IR and other advanced analytical techniques, and enhancing methods of human identification (criminal contexts) and verification (security contexts). (see appendix 1)

An illustrative example, includes a three year Body Modifications project (funded by the Leverhulme Trust). This is led by Dr Tim Thompson (an anthropologist) and focuses on the use of body modifications as a tool for human identification. This project investigates this under-valued form of identification through studies focussing on the increasing popularity of body modifications, their impact on the body and means of effectively recovering their information post-mortem.

Work in the Digital Futures Institute has included a project on the reliable forensic examination of computer evidence. This project concerned the repeatability and validity of existing and future methods of dealing with computer forensics. Current work is focused around network attack profiling. There are opportunities to further develop work in both of these areas.

SoFI has research expertise in face-recognition and has recently completed an ESRC grant to investigate recognition of own and other-race faces. Future plans are to develop this work for application to forensic science in the area of recognition of suspects with video technology as well as use within identity parades. We have specialist expertise in the development of police interviewing techniques and current work involves the development of a framework for investigating suspected sex offenders and murderers and investigating the effect of policy on interviewing techniques. Within SoFI work is also carried out on a number of empirical manifestations of 'organised crime' such the stolen car and car parts market, cocaine and ecstasy trafficking, cigarette smuggling, the counterfeit CD/DVD market, migrants smuggling and trafficking as well as the policing of 'organised crime'

1.2 Opportunities for future:
There are extensive laboratory equipment and facilities at Teesside. Our analytical facilities include GC-MS, LC-MS, ICP-MS, Raman microscopy as well as tools for molecular biology. Our micro and nanomanufacturing facilities for the fabrication of microfluidic devices includes clean room processes such as photolithography, wet and dry etching and sputtering as well as associated technologies such as photo electroforming, micro-milling, micro-injection moulding and laser microstructuring.

1.2.1 Teesside University has a good track record of creation of new companies, there is potential to create new technology companies within the forensic science area. One new award-winning spin-out company has already been created.

1.2.2 Many of our staff are drawn from a professional practitioner base, consequently we have particular strengths in practitioner-based applied research. We have good links and partnerships with employers which provide a good understanding of market needs. A potential opportunity could be to look at ways to automate parts of work the work carried out by relevant practitioners in the CJS. Actual practical experience for researchers may be useful in developing a better idea of the problems and opportunities for converting research into practice. Greater use could also be made of BSc and MSc projects within UK Universities.

Other organisations are also interested in the wider cybercrimes area, including computer forensics. We are engaged with EURIM, an independent UK based Parliament-Industry group for ICT products and services who have an indicated significant potential opportunities for research in cybercrimes.

There are also significant opportunities in the area of Fraud and Financial crime. We have previously carried out work with the former Australian High Tech Crime Centre on a project culminating in a published evaluation for that organisation of future trends in technology-enabled crime. We have also produced work on the nature of transnational organised cyber crime and have a researcher who was a designated expert on cyber crime at the Council of Europe's 'Octopus Interface Conference: Cooperation against Cybercrime' in 2009. We also have postgraduate researchers who have been working on issues of corporate governance in Nigeria which include financial statement fraud and identity fraud.

2. **What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency etc.?**

We work with a number of different regional and national agencies. Members of the Technology Futures Institute collaborate with many leading institutions, both nationally and internationally. Examples of on-going collaborations include those with universities in the UK (such as Durham, Southampton, Leeds and Birmingham) and overseas (such as Coimbra, Portugal and Columbia, USA, while we have a PhD student supported by the forensic science service in Chile), as well as organisations such as the Trading Standards Institute and the Food Standards Agency. Our recently formed regional level partnerships (Universities of Northumbria, Sunderland and Teesside together with the NPIA) facilitate practitioner-based applied research.

Research has been undertaken with forensic providers, including LGC forensics and Keith Borer Consultants. We have good links with our neighbouring police forces such as Cleveland Police for work related to large data handing and digital forensics e.g. we have a D Prof graduate in Cleveland police who works in their strategic IT area.
Teesside University is one of fourteen Universities working in collaboration with the HOSDB taking forward various aspects of fingerprint work. Teesside has an excellent practitioner base to support this applied research and now has a part time PhD looking at the recovery and enhancement of fingerprint from various materials recovered from crime scenes.

SoFI have extensive and successful partnerships with the police service including Cleveland Police, West Mercia Police, The Ministry of Defence Police and the Defence College of Policing and Guarding. Published research is within areas as diverse as: examination of cigarette smuggling, an examination of the Scottish youth justice system, the French youth justice

system, and the youth justice system in England and Wales, and the cartridge case ejection patterns from self loading pistols. We also have a wide range of partnerships for wide range of qualifications in fraud management and financial investigation and financial with West Midlands, Greater Manchester, West Yorkshire, City of London and Ministry of Defence Police Forces and with the National Policing Improvement Agency for the provision of qualifications across the full spectrum of qualifications.

3. **Can you give good examples in the forensic science field or translation into practice, and also any examples where this has been difficult or problematic?**

3.1 We have a good mix of high quality applied research with very significant expertise. We are developing techniques and methodologies for crime detection including enhanced fingerprint analysis working with a local police force fingerprint bureau, facilitating knowledge exchange between sectors. One spin-out company has been formed to develop and distribute digital tools for forensic anthropological research and practice, and is based on campus.

New technologies and methods developed by staff within the Technology Futures Institute have been applied to the crime and security field, while enterprise activity has successfully exploited this group's acknowledged expertise within the region and further afield.

3.2 Where this has been difficult or problematic:
Although having a good in-house core of practitioners it is often difficult to gaining access to other appropriate practitioners, particularly with reduced resourcing in terms of time and money. These practitioners are usually very happy to talk to us, but they simply don't have the time and resources to invest with Universities. The current (major) squeeze on police and related funding means that they just don't have any money; in some cases, staff are being deployed or given other work.

4. **What do you see as the opportunities for and the barriers to, the funding of research relevant to forensic science?**

4.1 A better recognition of the forensic science subject area through an academic QAA benchmark might help to attract more researchers into the field. The Home Office is viewed as the main source of funding for forensic science research. Other agencies such as the research councils and TSB should consider providing funding opportunities for the forensic science sector. The number of private sector partners that can participate in joint research projects has been limited. Although there seems to be some opportunities for growth in the private sector with a number of new companies emerging that can engage with academia.

4.2 Opportunities:
The research environment at Teesside is conducive to applied research and directed research in the workplace. Commitment and investment from the university is demonstrated through the existing equipment and facilities at Teesside
.

5. **What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?**

Staff within SoFI are founder members of the International Investigative Interviewing Research Group (IIIRG). The IIIRG was formed in 2007 and is a worldwide network of professionals, with collaborative interests, working with international bodies committed to improving investigative interviewing (internationally) and ensuring all improvements are underpinned by a robust evidence base. Please see http://www.iiirg.org/

SoFI is represented on the Cross-Border Crime Colloquium (CCC) which is a network that brings together experts on international organised (economic) crime to discuss the latest developments in empirical research, legislation and law enforcement, with a special geographical focus on Western, Central, and Eastern Europe. The CCC aims at building bridges in three respects: between East and West Europe, between scholars and practitioners, and between old and young.

A member of staff within SoFI has recently been appointed as an Associate of the Australian Institute of Criminology, a statutory research agency within the portfolio of the Minister for Justice, in order to '...strengthen our ties between the AIC's Global, Electronic and Economic Crime (GEEC) team and you as an expert on transnational crime'.

6. **Are there any other issues relevant to our terms of reference that you would wish to comment on?**

6.1 The implementation and validation of new technologies is key to ensure best evidence to the CJS and courts.

6.2 Opportunity to establish a national and international network /data bases of project knowledge to share best practice across the forensic arena.

Appendix 1
Examples of some current research within the forensic and crime scene areas

- Forensic Pathology & Human Identification
- Improved identification and analysis of fragmented human remains using FT-IR
- Taphonic changes to bone structure due to aquatic environments
- Determination of the cause of traumatic injury in the body and enhancing methods of human identification (criminal contexts) and verification (security contexts)
- Fingerprint - search, recovery and enhancement (Home Office Scientific Development Branch)
- Effectiveness of low copy DNA in criminal investigation
- Application of social cognition models to regulatory interventions
- The application of live video capture and spatially mapping in evaluation crime scene examiner competencies and investigative process

UCL JILL DANDO INSTITUTE CENTRE FOR THE FORENSIC SCIENCES

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

UCL is an internationally renowned, research-led university which has a wealth of wide-ranging expertise in the sciences, social sciences and humanities, the majority of which have realised or potential applications to the forensic sciences. The establishment of the UCL JDI Centre for the Forensic Sciences (CFS) brings together over 75 academics from more than 25 different departments to enable an excellent, strategic and focussed cross-disciplinary research programme in the forensic sciences. Our vision is to be a world leader in forensic science research that underpins and shapes the development of this discipline (www.ucl.ac.uk/forensic-sciences). We have close links with the UCL Security Science Doctoral Training Centre which currently has over 30 PhD students working on interdisciplinary security and forensic science research projects (www.ucl.ac.uk/secret/homepage).
CFS currently invests in three main areas of activity:

a. Hosting a *research programme* that stimulates cross-disciplinary research projects. This programme is designed to enable a more coordinated formulation of bids in response to emerging funding opportunities and the provision of cutting edge material for our new MSc in Crime and Forensic Science.
b. Driving academic and public debate by designing and hosting a series of *events* that bring together academics and forensic science stakeholders.
c. Promoting the visibility of our research, activities and postgraduate programmes to a wide audience and enhancing the academic, public and policy *impact* of our research in the forensic sciences.

a. Research themes

Our research programme draws on the diverse expertise across UCL and also upon the existing research projects that are being undertaken in UCL. The programme provides a coherent and focussed approach that is attractive to researchers, students, external bodies and policy makers, and which reflects the main issues currently faced by the forensic sciences. There are three priority research themes:

<u>The philosophy and nature of forensic science</u>

One of the greatest issues facing the forensic sciences today is its development as a coherent, robust, and rigorous academic discipline in the field of applied science. The philosophical framework of the forensic sciences is fundamentally different to the parent disciplines which are now being applied within a forensic context. Whilst a good body of theory has been developed in the primary sciences, there is a significant need to undertake experimental work that integrates the behaviour, analysis and interpretation of different types of evidence within a forensic context to establish secondary theories that provide a robust framework within which to practice forensic science in a meaningful and accurate manner.
Current work includes:

- Philosophical frameworks for the forensic sciences.

- Experimental studies to establish the behaviour (transfer and persistence) of different forms of evidence (DNA, fingerprints, soils, pollen/diatoms, glass, paint, hair, fibres etc).
- The interpretation and presentation of forensic evidence.
- The fallibility of forensic evidence.

The practice of the forensic sciences

A fertile research area concerns the practice of the forensic sciences whether it be establishing the best forms of analysis for particular forms of evidence, or developing innovative technologies to address particular forensic problems. The application of expertise developed in different disciplines to specific topics pertinent to the forensic sciences is a hitherto vastly under-explored research field which the Centre is well placed to develop and begin to provide answers that are both cross-disciplinary and innovative. Such a focus fosters innovation and we hope increases the capabilities of the forensic sciences to provide the means of answering the ever-growing number of issues that are faced in the detection of crime, terrorism and security.

Current work includes:

- Identifying the best techniques for the collection and analysis of different forms of forensic evidence in specific forensic situations.
- Application of current technologies in a novel forensic context to enhance the accuracy and/or efficiency of current forms of forensic analysis.
- Development of new technologies to address the practical challenges of preventing and detecting crime.
- Examining the use or exclusion of particular forensic techniques in the course of routine investigations and their implications for forensic science in the laboratory and the courtroom.

Perceptions of the forensic sciences

Forensic science is by its very nature embedded within the judicial system and governmental crime and policing policy and is therefore, also highly relevant to the public in general. The Centre draws experts together from many different disciplines to identify the current perceptions of forensic science amongst the general public, key players within the judicial system, practitioners and within offender communities. Research within this theme in turn also helps to more accurately shape the perceptions of the capabilities of forensic science. This is a particularly under researched area and one that has the potential to bear much fruit for the evaluation of forensic science practices, for establishing best practice guidelines for dealing with forensic science evidence in a court and for national and international crime policies.

Current work includes:

- Identifying perceptions of forensic science within different key communities and assessing their impact on the practice, presentation and limitations of forensic science within the UK.
- Exploring the presentation of complex evidence to a court.
- The role of statistics for the forensic sciences in general and for a courtroom setting in particular.
- The influence of and influences on expert witnesses.

- Assessing the influence of the media on the practices of investigators, prosecution and defence lawyers and jury members.

b. Events

The CFS is increasingly designing and hosting events to mobilise an interest in our work from academics, practitioners and policy makers and enhance knowledge transfer. Regular events include a research seminar series for academics and practitioners and a student seminar series dealing with various aspects of the forensic sciences of interest to students in many different faculties. We hold events designed to highlight current developments in the forensic sciences (such as the imminent Law Commission Report on the admissibility of the expert evidence), and contribute to international conferences (such as the International Crime Science Conference). CFS also aims to run events that enable different stakeholders within the forensic science community to brainstorm and communicate from their different perspectives to inform and direct future research projects and collaborations. Our events have so far attracted delegates from a variety of forensic science providers, the CPS, NPIA, SOCA, Home Office, Home Secretary's office, Forensic Science Society, Dstl, MOD, a number of police forces, consultancies, the judiciary, UK and US universities and the media.

c. Visibility and Impact

The CFS works hard to ensure that our research is accessible to a wide audience beyond our events programme.

MSc in Crime and Forensic Science

The Centre will be starting a new MSc course in Crime and Forensic Science (from September 2012). The new MSc course will offer students a unique opportunity to gain Forensic Science skills and methods within a holistic Crime Science grounding. Our course will produce graduates familiar with a scientific overview of crime which will ensure that the MSc equips them with a wide range of transferable skills so as to be good forensic scientists, managers, consultants and/or advisors in a variety of different crime, security and policy contexts. The skills developed in this MSc will produce graduates who have the potential to influence and develop the forensic sciences nationally and internationally.

Communications and Public Engagement

The Centre is in the process of developing a public engagement programme. We are establishing relationships with practitioners, policy makers and the judiciary to enable the Centre to take part in dialogue about the direction of its research with both end-users and stakeholders. Our aim is that this will ensure that the research has wide-spread exposure to the relevant communities and even more importantly has grass roots impacts. We hope to also establish interaction with those in the law profession through continuing professional development (CPD) courses (run with the UCL Institute of Judicial Studies) to provide a source of support to the legal community by equipping barristers and solicitors with the tools to deal with forensic science evidence and expert witnesses effectively and accurately. Through these courses our aim is to embed the procedures and processes of the court

system into the research and teaching programme of the Centre. The development of these relationships will ensure that the research programme addresses pertinent issues faced by those interacting with the different spheres of forensic science. The Centre is also developing a programme to widen participation in the sciences and their forensic applications by delivering primary and secondary school initiatives with the aim of inspiring a new generation of scientists with the desire to apply their knowledge and expertise to the forensic sciences.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

The UCL JDI Centre for the Forensic Sciences has a vision not only to facilitate world class research in the forensic sciences but also to undertake problem based research that has impact at the 'coal face'. To this end the Centre is currently developing research partnerships with a number of forensic science stakeholders including the Metropolitan Police, LGC Forensics and AWE. These collaborations range from co-funded studentships for PhD research (that is undertaken in collaboration between UCL and the industry partner) to developing knowledge transfer events in collaboration with industry partners, to facilitating stakeholder input to our teaching programme, to providing academic input to industry staff development and training courses.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

Many of the members of the Centre for the Forensic Sciences are expert witnesses who undertake work for the courts for both criminal and civil investigations. This enables the use of recent developments in the pertinent research fields to be utilised in work that is utilised as intelligence or even evidence in a court. For example the recent developments in the interpretation of DNA analysis and, in particular, mixed profile interpretation undertaken by UCL academics, have been utilised recently in terrorist cases tried in the UK courts.

The relationship between research and practice can also work conversely. Consultancy provides the researcher access to data and also experience of conducting research within the context of all steps in the forensic science process (scene management and sample collection, analysis, interpretation and presentation in court). This exposure very often precipitates new avenues for research and fuels innovations. For example, involvement in a number of recent cases has resulted in research investigating the issues surrounding the presentation of complex evidence to a jury and another case has led to a new research project dealing with the transferability of trace evidence and the potential for the implementation of social network theory to enhance intelligence capacities of trace evidence.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

The Centre is designed to enable better and more strategic mobilisation of academics for funding opportunities as they arise by providing a network of academics that fosters new, and maintains existing, collaborative relationships. We believe that an important aspect of securing the future of the forensic sciences will be to ensure the future of excellent, innovative, interdisciplinary research which currently is not well supported by national research councils, given the applied nature of the discipline often leading to bids 'falling between the cracks' or being moved from one research council to another.

We believe that persuading research councils of the strategic nature of the forensic sciences is crucial and developing dedicated funding streams vital for the UK to be the world leader in forensic science and to ensure that forensic science is a robust and credible discipline that is able to contribute to securing justice.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

There are a number of international networks such as the International Association of the Forensic Sciences (IAFS), the European Academy of the Forensic Sciences (EAFS) and the American Academy of Forensic Sciences (AAFS). These networks are highly influential in terms of producing the internationally peer reviewed journals in forensic science and holding international conferences to enable the sharing of research and best practice. The Australian and New Zealand Association for the Forensic Sciences (ANZFSS) in particular holds excellent conferences in terms of attracting the presentation of high quality and novel academic research across a very broad range of disciplines and at the same time attracting a diverse range of delegates from academia, forensic science providers, the police and those in intelligence fields.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

We believe that there is a need for research centres of excellence devoted to the development of forensic science research that will underpin the discipline, foster innovation and secure the future of the forensic sciences. It will be vital that such centres are integrated into the various forensic science stakeholder communities to ensure relevant research is undertaken and also that such initiatives are supported financially.

Submitter details:
Dr Ruth Morgan
Director, UCL JDI Centre for the Forensic Sciences
UCL Department of Security and Crime Science
2nd Floor Brook House
2-16 Torrington Place
London
WC1E 7HN

ULSTER UNIVERSITY

1. The University delivers to non medics PgCERT in forensic studies for graduates from many different disciplines who want a taster for forensics but may not be in work placement in a related area. In addition student intake for this would be crime scene officers, coroner office staff etc non medics who are in this field and who perhaps deal more so with evidence and the crime scene.

2. The University delivers PgCERT PgDIP MSc in Forensic and Legal Medicine for forensic medical examiners it medically qualified students who undertake this line of work and deal with rapes/ suicides/ suspicious deaths....so they deal with the person not the crime scene.

3. As of April 1st 2011
   http://news.ulster.ac.uk/releases/2011/5683.html
   Ulster University now delivers two more courses under a Department of Health UK funded e learning initiative with the Royal College of Physicians Faculty of Forensic and Legal Medicine.
   One course is aimed at social workers, midwives, nurses, health visitors, paediatricians etc basically any health care profession or professional who comes into contact with potential victims of sexual assault: men; women; or children or infants. We cover the legal aspects and the physical and mental aspects....this is essentially a learning preparatory course and after students complete it they go on to take the DFCASA Diploma in the Forensic and Clinical Aspects of Sexual Assault by the Society of Apothecaries of London which sets national standards in the quality of care medical professionals provide for victims of sexual violence and abuse
   The second course is similar but it prepares medics and medical legal advisors for the Royal College of Physicians, London, for their FRC Path equivalent membership examinations and we cover the syllabus for their legal part 1 exam and sexual offences medicine part 2 exam.

4. Ulster University is doing a presentation to Department of Health, London this month again and hope to win further funds to develop the general forensic medicine e learning tool also for delivery next year so that would cover all other aspects of forensic medicine. In general we cover all laws in the DoH courses and therefore we can take students from anywhere in the world.

5. University publishes papers from the Masters year of research despite the ethical review panel passing out at the proposed projects ..see relatively recent list at
   http://www.taramoore.org/publications/peer-reviewed-forensic/

6. Ulster University has a number of prizes for our MSc forensic research students, you can find them listed within this link:

http://www.taramoore.org/academic-prizes/
Currently we have over 70 students studying Forensics.

7. If you require any further information, please do not hesitate to contact me.

Submitter details:
Professor N D Black
Pro Vice Chancellor (Research and Innovation)

CENTRE FOR INFORMATION OPERATIONS [CIO], UNIVERSITY OF WALES, NEWPORT

What work relevant to forensic science is being done in your group and what are the opportunities for the future?

1.1 Collection of information from large scale heterogeneous computing infrastructures.

The aim of the project was to conduct a feasibility study on mining, categorising and classifying (based on a pan-governmental vocabulary) information from heterogeneous large scale computer infrastructures and storing/fusing the results in a forensically sound manner, while destroying the duplicates and without disrupting daily staff operations.

In 2007 the UK's government identified a number of needs for public sector information. Those that related to this project were the following:

- Improve responsiveness to demand for public sector information,
- Ensure the most appropriate supply of information for re-use,
- Improve the supply of information for re-use,
- Promote innovative use of public sector information

Collecting information from a large scale heterogeneous computing infrastructure is a challenge with the following problems: Scale, Cost, Responsibility, Context, Irretrievability, and admissibility. We concluded on a solution for addressing and overcoming the above problems while meeting the aforementioned needs.

1.2 Digital Continuity of Electronic Records in the Welsh Assembly Government

Digital forensics is a generic term that covers all aspects of the examination and recovery of material that resides on digital devices. It is often associated with the investigation of computer crimes, dealing with a number of situations from industrial espionage to damage assessment.

However, digital forensics can be applied in any computer based environment that requires collection and analysis of digital data. Therefore, it can be described as a specialised approach of data manipulation that allows the examination of the content of the files in a digital forensics manner. The digital media is preserved and the actual 'evidential' content remains unaltered during the examination of the data.

The digital evidence is any kind of digitally processed information that is stored in any sort of digital media. Residual data on digital media can recover the digital trail of the media. It provides valuable information about the history of the system that could be treated later based on their content and importance. The data recovered enhance the purpose of the investigation process as the digital forensics analysis provides accurate and reliable results.

The Enterprise Resource Management System (ERMS) pilot application for the Welsh Assembly Government (WAG) requires the electronic records to be organised into electronic files. We presented a framework for structuring the electronic data of the WAG active filing system. The project is still in ongoing research. The effective contribution and application of digital forensics in the project plays a key role in achieving the desired result. An analytical forensic based procedure enables a more straightforward and speedier analysis of the existing data.

1.3 Automated On-line Vulnerability Identification System

The Automated Online Vulnerability System (AOVIS) is a system that assesses the security level of a desktop computer by checking whether certain information security software is installed, and whether the installed applications are up to date. The results are then sent back to a server for issuing a kite-mark certification to the owner of the computer.

AOVIS ensures anonymity as no personal information is being collected and the certification process is being initiated by the computer user and not by the AOVIS server. A number of requirements have been identified to satisfy European and UK legislation regarding personal information and data protection.

Based on those requirements two different architectures were proposed: one being a simple two-tier system that is “heavy” on the client side, and one being a three-tier system that also ensures the integrity and confidentiality of the assessment and of the communication between the servers and the clients by using a Public Key Infrastructure. Furthermore, it ensures the availability of the AOVIS service by employing a number of redundancy techniques.

The complexity of the second system is exponentially higher that that of the first system, but the benefits of offering a more complete and continuous service probably overwhelm the complexity issue. The recommendation was for the development of a pilot application in order to identify bottlenecks, assess performance and conduct a full scale penetration test.

1.4 Forensically Reconstructing Unknown Broken File Chains Using HSOM Algorithms

It’s been accepted by Cloud Computing vendors that retrieving data from a cloud environment once they have been deleted is next to impossible. This constitutes a major hurdle for the digital forensics examiner as it greatly limits the pool of potential evidence that could be collected during an investigation. We proposed a solution to the above problem that spans across two different worlds: the world of digital forensics and the world of artificial intelligence.

Block-based hash map analysis works by calculating a hash value for each block of the target file that would be allocated a sector or cluster to store its data. The block hashes are then stored in a “map” file. The

examiner then searches secondary memory areas to see if they contain blocks matching those contained in the “map” files. The examiner then has the ability to rebuild any file whose blocks have been located. The processes of hash-map calculation and analysis in the case of graphic images is accomplished using a single, dual-purpose EnScript in EnCase. Where a suspect file has been partially but not completely located the script will produce a PNG graphic showing exactly which blocks of the graphic have been located.

This technique is extremely time and processor intensive, and does not work for unknown broken files. We have developed HSOM algorithms in order to reconstruct broken chains of previously unknown files, in order to be examined by the digital forensic examiner using the block-based hash map analysis technique.

1.5 Managed 1 SIP and 3 RSIPs with British Law Enforcement Agencies and Digital Forensic Companies

The purpose of the SIP was for the academic to get field experience in digital forensics and of the legal proceedings that follow a successful investigation. The purpose of the RSIPs was for the academics to understand current practice in the field of digital forensics, share experiences and knowledge and also assess and evaluate the teaching strategies and the learning methods employed by the CIO for training digital forensic investigators.

1.6 E-Crime Wales

Members of the e-Crime Wales Steering Committee since 2008. We offer strategic advice on how to tackle e-crime and secure the Welsh cyberspace. We participate in a number of initiatives in Wales and we organise events to promote the science of digital forensics and disseminate the results of our research.

1.7 Determine trust and user acceptance of ‘Zero Latency’ Knowledge extraction of search to provide actionable answers

A movement, aptly named ‘Zero Latency’, signals the ability of computers to comprehend the concepts and context of unstructured data, enabling people to extract significant value and make accurate real time decisions. Zero Latency search results extends far beyond conventional Keyword Search, which simply allows users to find and retrieve data in a headline, synopsis, link format; instead Zero Latency understands the relationships that exist between disparate pieces of information and perform sophisticated analysis operations, automatically and in real-time.

We are looking in using the technique as part of the e-discovery process. The argument is that simply looking into the file metadata is not always providing the decisions makers with enough information regarding the file classification. We want to be able to provide the decision maker with an automated method, complementary to the existing e-discovery method, for making a decision regarding file preservation.

1.8 Embedded Software Platform for use in Live Forensic Investigations

Live digital forensics is an emerging and rapidly growing area of interest for the computer forensic investigator. Live digital forensic investigations require appropriately trained personnel to be able to successfully perform an acquisition while in the field. This expertise is rarely taught as a pre-requisite to current law enforcement officers who work within the UK's many High-Tech Crime Units (HTCUs). Project LIFE (Live Investigation of Forensic Evidence) proposes a different approach to the current methods employed for extracting live volatile data from a target machine. These methods will attempt to alleviate the need for advanced technical training and allow law enforcement officers at all levels to be able to complete the acquisition of live volatile data from suspect target machines.

We are designing a dedicated embedded platform installed on a handheld computing device, containing only software applications required for volatile data capture. An officer or investigator with a limited knowledge of live digital forensics would be able to perform the acquisition. The handheld device connects locally to a target machine, is able to capture relevant data, store that data as digital evidence in a secure and verifiable manner and allow an investigator to view the results from the device if necessary.

1.9 Digital Forensic Investigations in Cloud Environments

There is still very little known about the cloud model nationally in the United Kingdom and how an effective digital forensic investigation will be conducted into cloud related cybercrimes. The current high exacting standards required of both the 'Association of Chief Police Officers' (ACPO, 2007) and the judicial system in England and Wales, together with the judicial systems of Scotland and Northern Ireland, mean that law enforcement agencies may not yet be suitably equipped to deal with investigations of cloud related cyber crimes. Alarmingly, between 70%-80% of criminal cases investigated by local 'High Tech Crime Units' (HTCU's) in the UK are related to child exploitation and paedophilia. Research and testing of the cloud, has illustrated it would be possible for a paedophile to utilise cloud resources in a virtually anonymous and undetectable environment. Cross-border legislative issues that an investigator may encounter will also significantly affect the outcome of many cases that will inevitably be heard in the UK courts.

We are working closely with vendors of cloud services, law enforcement agencies, private digital investigation professionals and other relevant organisations and individuals, to establish ways of ensuring evidential artefacts of digital data will stand up to the close scrutiny of the judicial systems of the UK.

What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Agency, etc?

The partners of the CIO are:

- Guidance Software
- Prolinx Limited
- Scottish Drug Enforcement Agency
- Bond Solon
- E-Crime Wales
- Gwent Police
- Athena Forensics
- Cardiff University

Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

It is “difficult” to apply research results to live environments. The users of the environments require changes in their current practice in order to address their needs. The custodians of the environments by definition do not like “change” and anything that might destabilize the environment or/and will go against existing policies. Research by definition is promoting and enforcing change. It is our experience that even setting up test-beds for applying and evaluating research results is extremely challenging.

The public sector is too cumbersome and rigid. It does not have the flexibility that is required for conducting research; hence the simplest research task is proving to be extremely costly as “flexibility” has to be bought out.

The above applies for Police Forces and other Law Enforcement agencies.

What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

It makes sense for the Universities, private companies and law enforcement agencies to form consortiums and participate in research; be it blue sky or applied. We believe that we have achieved a critical mass of specialization and expertise in the academic sector to be able to sustain those partnerships around the country. The end user (law enforcement agencies) should be approaching the Universities for feasibility studies. The Universities will be offering solutions for the consortiums then to develop and implement. There are opportunities through the various research funding bodies in the UK, but the end user hasn’t got the culture for exploiting them.

ABERYSTWYTH UNIVERSITY – NIL RESPONSE

Dear Dr Williams,

Following extensive consultation with the research community here, in both the Sciences and Social Sciences, I fear we do not at present undertake any work in the field of forensic science that would fall within the ambit of your review.

Yours sincerely,

Aled Jones

Yr Athro Aled Gruffydd Jones / Professor Aled Gruffydd Jones
Dirprwy Is-Ganghellor (Ymchwil)/ Pro Vice-Chancellor (Research)
Prifysgol Aberystwyth / Aberystwyth University
1 Maes Lowri / 1 Laura Place
Aberystwyth SY23 2AU
Cymru / Wales,
Y Deyrnas Unedig / United Kingdom.

EDGE HILL UNIVERSITY – NIL RESPONSE

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future? None at present

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.? None at present

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic? N/A

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science? N/A

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention? No

6. Are there any other issues relevant to our terms of reference that you would wish to comment on? No

Submitter details:
Nikki Craske [Nikki.Craske@edgehill.ac.uk]

OXFORD BROOKES UNIVERSITY – NIL RESPONSE

Dear Professor Silverman,

This is just to let you know that Oxford Brookes University doesn't conduct any research into Forensic Science and doesn't have any plans to either.

With best wishes,
Anne-Marie Kilday.

Dr Anne-Marie Kilday MA, PhD, FRHistS, FHEA
Acting PVC Research
Associate Dean for Research and Knowledge Transfer and Teaching Fellow
Faculty of Humanities and Social Sciences Oxford Brookes University

ROYAL COLLEGE OF ART – NIL RESPONSE

In response to your letter of 16 February 2011 I confirm that the College does no work relevant to forensic science.

Alan Selby
Registrar
Royal College Of Art
Kensington Gore
London
SW7 2EU

INDIVIDUAL RESPONSES

INDIVIDUAL RESPONSE: COLIN AITKEN, CHAIRMAN, ROYAL STATISTICAL SOCIETY, STATISTICS AND LAW WORKING GROUP

Questions for researchers

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

EPSRC CASE award in collaboration with Mass Spec Analytical (MSA) in Bristol, assessing the evaluation of evidence in the form of drugs on various substrates, in particular bank notes.

There are various other informal activities, the main ones of which are described below in responses to other questions.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

I have had an EPSRC 'Think Crime' partnership with Forensic Alliance. The main objective was the development of robust procedures for the evaluation of evidence for multivariate models with different structures in addition to continuous variables and in the absence of population data. Dr. Tereza Neocleous was appointed as a research associate and now has an open-ended lectureship in the Department of Mathematics and Statistics in Glasgow. Papers have been published but with the Institute of Forensic Research in Krakow as collaborator, not Forensic Alliance. The link with Forensic Alliance did not prove fruitful; despite expectations the evidence type of most relevance to the project was not part of their portfolio.

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

(a) Procedures for the determination of sample size, published initially as a paper in Series A of the Journal of the Royal Statistical Society in 1997, then as a paper in the Journal of Forensic Sciences in 1999 and implemented throughout Europe by the European Network of Forensic Science Institutes (ENFSI) and published by the United Nations Office on Drugs and Crime in 'Guidelines on Representative Drug Sampling'.
(http://www.enfsi.eu/page.php?uid=195; last accessed March 15th 2011).

Aitken C. G. G., Sampling—How big a sample?, *Journal of Forensic Sciences,* JFSCA, 1999, 44(4), 750-760.
Aitken C., Bring J., Leonard T., Papasouliotis O., Estimation of quantities of drugs handled and the burden of proof, *Statist. Soc.,* 1997, 160(2), 333-350.

The sampling ideas are generic and have been used for sampling in cases involving on-line child pornography (only a subset of files needed to be inspected with a consequent saving in stress-related illnesses from the inspecting officers) and pirated CDs (only a subset of CDS needed to be inspected with a consequent saving in resources).

(b) I had an EPSRC 'Think Crime' award for collaboration with the Scottish Drugs Enforcement Agency (SDEA), a collaboration which was unsuccessful as we were more interested in long-term research problems than they, as a covert organisation, were. There is perhaps a difference in views as to the meaning of research between universities and commercial providers or police institutes, exemplified by our experience with the SDEA. Universities are used to long-term generic projects with large long-term generic benefits. Commercial providers and police institutes often look on research as a quick solution to a very specific problem, with each problem requiring its own specific solution. The long-term benefits of generic solutions are not appreciated and resources are not made available to fund them..

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Collaborations with SDEA and Forensic Alliance have not been successful. Collaborations with the Institute of Forensic Research (Krakow) and with the Institute of Police Science in Lausanne have been.

A major barrier is the lack of recognition of forensic science as a discipline for which there should be research funding, separate from academic disciplines such as chemistry and biology. More initiatives such as the EPSRC 'Think Crime' initiative would be welcome.

There needs to be a research and development institute in forensic science. A statistics and interpretation group exists in the FSS at present. If the FSS were to close, an independent national forensic science institute with core funding from the public purse needs to be established. Further details are contained in the submission from the Royal Statistical Society.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

I have several international collaborators of whom the most important are:

(a) Professor Franco Taroni, Institute of Police Science, University of Lausanne, Switzerland (Franco.Taroni@unil.ch)

(b) Dr Grzegorz Zadora, Institute of Forensic Research, Krakow, Poland (gzadora@ies.krakow.pl)

(c) Dr. Daniel Ramos, ATVS-Biometric Recognition Group, Universidad Autonoma de Madrid, Spain. (Daniel.ramos@uam.es)

(d) Professor Marjan Sjerps, University of Amsterdam and The Netherlands Forensic Institute (NFI), The Hague, The Netherlands. (m.sjerps@nfi.minjus.nl)

Professor Taroni and I are co-authors of three books and of many papers. Dr. Zadora and I are co-authors of several papers, and with Dr Ramos are co-authors of a paper about to be submitted for publication. Professor Sjerps

and other statisticians at the NFI and I have had many informal meetings and I have presented seminars at NFI.

In addition, there is an informal group of European researchers in forensic statistics, FORSTAT, which meets annually in conjunction with the FORSTAT statistical training workshops run jointly by Dr. Zadora in Krakow and myself in Edinburgh; these are both supported by the European Network of Forensic Science Institutes (ENFSI). The research group is chaired by Dr Ivo Alberink of the NFI (i.alberink@nfi.minjus.nl). The meetings have strengthened research collaborations across Europe. Two group-wide research applications to FP7 calls have passed the assessment process but failed to receive funding. A project linked to FORSTAT and training in evidence evaluation in general throughout Europe has received funding from the European Union and is coordinated by Dr Sheila Willis, Director of the Forensic Science Service in Dublin.

There is a triennial conference on Forensic Inference and Statistics, the first two of which were held in Edinburgh and the eighth is to be held in Seattle, Washington, USA, under the chairmanship of Bruce Weir in July 2011 (http://www.biostat.washington.edu/icfis2011/). This has been an extremely successful conference and is the only international forum at which lawyers, forensic scientists and statisticians meet together.

There is a workshop 'Science meets Justice: Forensic Statistics at the Interface' at the Lorentz Center in Leiden, The Netherlands, April 26th to 29th, which I will be attending along with many international researchers in Law and Statistics. As it is yet to be held, its usefulness has to be established but the willingness of the Lorentz organisers to fund the workshop is a measure of the importance with which the topic is viewed.
http://www.lc.leidenuniv.nl/lc/web/2011/454/info.php3?wsid=454.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

Until last year, my successful collaborations have all been with scientists funded by a public purse somewhere.

The CASE award in collaboration with MSA Bristol is the first project with a commercial provider which I feel has the potential to be very successful. However, this has taken several years to come to fruition and is with a provider of very specialist forensic services. It is not clear to me that general commercial providers or police authorities will be so willing to support research projects with such long time scales as a PhD project.

If the FSS were to close, the creation of an independent national forensic science institute with core funding from the public purse is the only way in which research and development can be continued.
Recommendation 1 of the 2009 National Academy of Sciences report from the USA (http://www.nap.edu/catalog.php?record_id=12589) should be studied carefully and a version tailored to the UK legal system developed.

The following comment on p. S-15 of that report, immediately following Recommendation 1, is of relevance:

"The benefits that will flow from a strong, independent, strategic, coherent, and well-funded federal program to support and oversee the forensic science disciplines in this country are clear: The Nation will (1) bolster its ability to more accurately identify true perpetrators and exclude those who are falsely accused; (2) improve its ability to effectively respond to, attribute, and prosecute threats to homeland security; and (3) reduce the likelihood of convictions resting on inaccurate data. Moreover, establishing the scientific foundation of the forensic science disciplines, providing better education and training, and requiring certification and accreditation will position the forensic science community to take advantage of current and future scientific advances."

It is not clear there is a research culture in forensic science in the UK, outside a few people who work in the current Forensic Science Service and some scientists in a few UK universities. The closure of the Forensic Science Service and the failure to establish an independent research entity in forensic science, with government support will be very detrimental to the administration of justice and will be very expensive in the long-term through a higher crime rate and through miscarriages of justice.

It is not realistic to expect most practitioners to have PhDs. However, if practitioners operated within a research culture their critical thinking skills would be enhanced considerably. It is also unrealistic to expect law-enforcement agencies tasked with the detection and solution of crime to support open-ended research. The institutional separation of laboratories from the law enforcement apparatus is essential in order to reduce the dangers of partisanship and to foster a culture of research.

There has been very little national funding for research in forensic science. The EPSRC 'Think Crime' initiative is a good example of what can be achieved but there has been little, if any, further support.

Doctoral-level training in forensic science could be established. An example would be the creation of academic doctoral programmes in which there were subject-specialists training forensic scientists and forensic scientists training subject specialists.

INDIVIDUAL RESPONSE: DAVID BALDING UCL GENETICS INSTITUTE

I am writing to you in response to your invitation to researchers to contribute evidence to the above review.

My Backround:

7. I have 20 years experience of research relevant to forensic science, which I estimate corresponds to perhaps 20% of my personal research effort over this time, none of it funded from any external source other than HEFCE core funding. I have published forensic-related articles in law, statistics, forensic science, genetics and general science journals, refereed many forensic science papers and a few grants, and published a monograph on DNA evidence interpretation.
8. My research has been in relation to the statistical interpretation of DNA profile evidence, particularly population genetics aspects and issues of relatedness, but also more general interpretation issues such as the effects of database searches and of partial profiles. There remains considerable work to be done in the area of interpretation of DNA profile evidence, particularly for low-template profiles and for complex mixtures and relatedness.
9. I have given expert witness evidence in >100 cases, mainly in the UK but also in the US, Ireland and Australia. Fees from this work subsidise some research expenses, for example conference attendance and publication fees, but cannot support any substantive research.
10. I have since 2008 been the scientist member of the FSS External Advisory Group and a member of the Forensic Regulator's DNA Specialist Group; the former is remunerated the latter is not. As well as my link with FSS, I have also had more limited involvement with LGC and Orchid Biosciences.

Some Comments on forensic science R & D

11. I am struck by the disparity in the UK between the importance of forensic science to society, and the lack of both research funding and policy initiatives to encourage or co-ordinate research in this area.
12. My own research effort has usually been short-term, driven by immediate and tremendous need arising from court cases. In my view, lack of systematic academic research effort into many questions confronting courts, particularly relating to DNA evidence as it has evolved over the past two decades, has led to protracted and inadequately-informed debate in courtrooms. I have often given

evidence in court similar to this: “There is no research to answer this question, it could be answered given some resources but there is no funding available”.

13. Lack of research investment has I believe led to the introduction of inadequately-researched innovations in some types of evidence (although I don’t see this as having been an important problem for DNA evidence).
14. I am aware of frustration among those trying to pursue an academic career in forensic science research in the UK, because despite great need and much opportunity for progress there is little opportunity to attract funding from research councils or other sources.
15. Although industry supports research internally, this is often in a climate of commercial secrecy with limited opportunity for discussions/criticisms from outside the forensic science world. There is a great need for this to be complemented by more publicly-funded research that is broader in scope, through not being driven by commercial imperatives, and subject to the usual academic principles of openness to criticism from a wider research community. More public funding to encourage industry/academic collaboration would also be welcome. I don’t have any data on how much of this is already going on but I have a strong impression that it is much less than is justified by the need, certainly in relation to other areas of science funding.
16. In my role on the FSS EAG, I have given some informal consultancy advice to FSS R & D staff. I am impressed with the quality and integrity of the staff that I interact with, and also that the FSS has maintained substantial R&D activity despite a severe financial climate. I am aware of innovative research projects being developed at the FSS that are of potentially great value for criminal justice. I am also aware from my discussions with FSS of difficulties in the process of bringing research innovations into the criminal justice system. It appears that the introduction of competition and competitive tendering has contributed to a reduced co-operation among different agencies that I believe has been detrimental to the public interest.
17. I have also become aware of conflicts between the requirement for a private company to protect its IP and courts’ demands for open access to all the data and methods underlying forensic evidence. I understand that this has in recent years led to costly legal disputes.

I hope that these few comments are of some assistance and would happy to answer further questions if requested.

INDIVIDUAL RESPONSE: DR ITIEL DROR, INSTITUTE OF COGNITIVE NEUROSCIENCE, UNIVERSITY COLLEGE LONDON

Cognitive Issues in Forensic Comparisons and Decision Making

Cognitive issues in making forensic comparisons and decisions are major issues, and have been recognised by the US Office of Inspector General (Fine, 2006) investigation into the erroneous identification of the Madrid bomber, and the US National Academy of Sciences (NAS, 2009) investigation into forensic science.

The world leading research into cognitive issues in forensic comparisons and decision making is based in the UK. This work is conducted by Dr Itiel Dror and his team from University College London (UCL) and Cognitive Consultants international (CCI) (e.g., Dror & Mnookin, 2010, and Dror & Rosenthal, 2008; for a review, see Dror & Cole, 2010).

This research is funded by the US government. For example, over $2,250,000 has been given to Dr Dror and his team by the US National Institute of Justice (NIJ), the National Institute of Standards and Technology (NIST) , and the Federal Bureau of Investigation (FBI).

These research grants are funding a variety of projects lead by Dr Dror, such as "Forensic Expert Error as a Function of Visual Complexity and Cognitive Difficulty", "Forensic Decision Making on Suitability for Identification Judgments", "Personnel Selection and Evaluation Tools for Forensic Science Managers", "Quantified Assessment of Technological Contextual Information on Accuracy and Reliability of Forensic Decision Making", and "Scientific Review of Friction Ridge Examination Protocols and Procedures". Further details are available at: www.cci-hq.com.

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INDIVIDUAL RESPONSE: PROFESSOR PETER GILL, UNIVERSITY OF STRATHCLYDE

Forensic Science Research in the UK – towards an integrated framework.

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1. Introduction

1.1 In the mid 1960s, Home Office policymakers had the foresight to create the Home Office Central Research Laboratory at Aldermaston. It later evolved into the Central Research and Support Laboratory (CRSE) in order to emphasise its support function. Policymakers had the vision to position the facility independent of law enforcement agencies in order to protect its neutrality. This model existed when the 'new wave' of DNA technology was introduced in the mid 1980s. By capturing, modifying and implementing the new technology, CRSE acted as a rapid response hub, not only for the UK but by providing comprehensive training courses, was able to devolve the technology to the whole of Europe and beyond. It is proposed that there is still a requirement for a centralised research centre of excellence that is fully integrated into the national framework of forensic science in the UK.

1.2 We must accept that the environment has changed over the past 40 years, yet the requirements are more or less the same. Before we can define how the new research unit will operate and function, there is an *a priori* necessity to define the optimum framework *before* we can decide how best to integrate the research function. This is particularly challenging within the UK environment because no other country in the world has adopted a solely commercial framework for forensic science. Consequently, there is no clear model to follow. In this paper I urge the policy makers to concentrate their efforts to closely examine the conditions that existed more than 25 years ago to understand how a proven model can work.

1.3 Today, forensic services within the UK are fragmented.

1.4 It is proposed that the various constituent parts are reintegrated in order to encourage cooperation and standardisation between forensic providers. In order to operate within a mix of public/private enterprises, it is proposed that a centralized research function that is publicly funded is essential in order for research to be used for public benefit. The research function should reside within a coherent framework that includes: the

Forensic Science Regulator, specialist casework, accreditation bodies, the private laboratories, and the national DNA database. See fig 1.

2. International connections:

2.1 I have strong international connections. I am a member of the European Network of Forensic Science Institutes (ENFSI), the European DNA Profiling Group (EDNAP),the International Society of Forensic Genetics (ISFG). I am chair of the methods/interpretation sub group of the DNA working group of ENFSI. I have chaired a number of the international DNA commissions of the ISFG. I was international research fellow, ESR New Zealand and I work closely with the NZ/Australia BSAG group as an advisor.

2.2 The international societies are the life-blood of forensic science. Our discipline is highly internationalised and is responsive to politically driven pan-European initiatives such as the integration of national DNA databases under the Prüm Treaty.

3. National Funding experience

3.1 My brief experience of attempting to obtain funding from the research councils has been unsuccessful. I have applied for funding under responsive mode. Under this scheme the project is circulated amongst the research councils in order to find a 'fit'. However my application "a proposal to investigate error rates in European national DNA databases by computer simulation" failed because none of the research councils (primarily BBSRC and EPSRC) would accept forensic science as part of their remit.

3.2 I concluded that it was futile to apply for non-existent funding streams.

4. International framework – Forensic science and EU policy

4.1 I work primarily with organisations external to the UK. My main focus is within the scientific societies (ENFSI/EDNAP/ISFG) which are closely interlinked. ENFSI is the 'official' scientific advisor to the EU policy makers . For example, the ENFSI recommendations to upgrade the multiplexes were subsequently adopted by EU Council resolution[1]. This policy has major implications for the way in which DNA profiles will be interpreted not only within the EU, but globally, for example with the Interpol standard set of markers. The ENFSI group currently coordinates the EU funded data-exchange project. This analysis will underpin the new

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2009:296:0001:0003:EN:PDF

multiplexes shortly to be introduced throughout Europe in support of the Prüm agreement.

4.2 ISFG is the main academic society for DNA specialists and has an international peer reviewed journal: ' Forensic Science International: Genetics'. The ISFG coordinates the DNA commission, an influential body responsible for setting standards and recommendations. These are important court-going documents. ISFG organizes a biannual conference and runs workshops devoted to practical applications – e.g. Statistics and interpretation of complex evidence.

4.3 EDNAP is a working group of the ISFG. The group organises collaborative exercises and has published extensively.

5. Towards a cohesive framework for forensic science within the UK

5.1 The main purpose of this paper is to provide advice on the requirement to provide a sound research base for the UK that is both efficient and cost effective. It is based on my experience as 26 years in the Forensic Science Service and three years in academia. I was a former Head of Department (Biology) at Home Office CRSE, and Principle Research Scientist. I therefore claim unique perspective in the various issues of concern from several different points of view: public (civil service) sector, private (FSS GovCo) sector, academia (Strathclyde University) and my position as Professor of Forensic Genetics at Oslo University - *this laboratory is a well-funded centralized facility that carries out research and casework in the same building for the whole of Norway and is in the public sector.* I have existing collaborations with every state in the EU, via ENFSI/EDNAP/ISFG, and also with the US, New Zealand.

5.2 My premise is that research in forensic science should follow a model that has been proven to work. We can readily identify a *'golden decade'* between c.1985-1995 where the majority of 'ground-breaking' research was carried out by the Forensic Science Service when it was under the auspices of the Home Office Central Research and Support Establishment (CRSE) based at Aldermaston and latterly at Birmingham.

5.3 It is worth evaluating the *special reasons* that existed at that time. It is not disputed that the CRSE led the ground-breaking work during that period of time as the work laid the foundations of current day practice world-wide.

5.4 It is misleading to believe that success in forensic 'research' depends solely on competitive funding. The nature of forensic science is such that it cannot be defined or carried out properly in isolation of a casework environment. I am concerned that this culture has been eroded

and cannot be properly emulated within the academic environment, which tends to be isolated from routine casework laboratories.

5.5 Research in the UK should be for public benefit and the proceeds must be made available equally to all providers. This strongly indicates the desirability of a cohesive public/private partnership.

6. An historical review – an explanation of the framework that existed

6.1 I concentrate on the post 1985 period as this was a *once in a century* opportunity that could easily have been missed if conditions had been different (*it is very clear that if the conditions that exist today, existed 27 years ago, then the 1985 revolution would not have taken place in the UK)*

6.2 In 1985, DNA profiling evidence was developed - the first demonstration of its utility in forensic science was a joint project between Alec Jeffreys and the CRSE. New extraction methods were developed at the CRSE, including a novel method to isolate sperm cells from vaginal cells, and this resulted in publication in Nature in the same year(1):

7. Review of the framework and conditions that made the DNA revolution possible

7.1 The funding for the project came from funds that were quickly diverted from within CRSE. There was no Home Office policy to generate IP (intellectual property protection) because the ethos of research for public benefit was the official policy at that time.

7.2 This meant that there was minimal delay – i.e. the funding was immediately available in August 1985 as a result of an internal application for funds. *An external application could take a year – and would be too late to have impact.*

7.3 The first project was completed in December 1985 and published in Nature. *This entire first phase was completed less than six months after the first collaborative experiments*.

7.4 The ability to respond quickly was of crucial importance to establish a ‘world-lead’. Other researchers would have quickly filled the void if we had not been in a position to a)to identify the possibilities b) to adequately fund the research.

7.5 A new development is of no use unless it can be implemented into casework. This is something that cannot be achieved by an academic institution. This is why CRSE was of crucial importance to bridge the gap between academia and casework.

7.6 CRSE was ring-fenced for research but there was a close relationship with the Aldermaston operational laboratory, housed in the same building,

7.7 This meant that an ‘implementation team’ of researchers and caseworkers could easily be formed.

7.8 The researcher benefits from close interaction with caseworkers *and vice versa.*

7.9 The researcher assumes responsibility for the implementation phase. Handover requires validation and this is usually a joint venture where the research-casework interface is essential. Validation is required to carry out the necessary testing

7.10 Once validation is ‘completed’ there is a gradual handover phase, where there is a researcher-caseworker interface that jointly process the first cases for court going purposes.

7.11 The first casework requires court-going support by the researchers who champion the project *with support from the Regulator (note that the Forensic Regulator function did not exist at that time).*

7.12 Once the first cases are reported, the researchers effectively return to carrying out research (in order to ensure that new products are being continually developed).

7.13 However, there is usually some requirement for *post-hoc* validation associated with challenges or new advances in the field. There may be requirement for the researchers to attend court as the *originator* of the method. This is especially likely if the technique is novel and there has been little or no peer review. Courts need to be assured that a technique is fit for purpose and is properly used within the context of a given case. Often, it is more important to describe what a technique <u>cannot</u> be used for, rather than what it <u>can</u> be used for (i.e. to define the limitations).

7.14 There is scope for caseworkers to have sabbaticals within the research group. It is highly desirable that researchers are exposed to casework and actively report some cases in order to give them the necessary perspective.

7.15 Similarly caseworkers have a perspective of research – this interaction is important to generate new research proposals.

8. Some examples of CRSE successes

8.1 Demonstration of the first DNA-based forensic proof in principle(1)

8.2 The first DNA national screen following the Pitchfork case(2)

8.3 Development of single locus probes c. 1989 and implementation into casework

8.4 Development of first STR ‘quadruplex’ system

8.5 First demonstration of utility in the Waco, Texas disaster.

8.6 Development of the SGM system¨

8.7 Development of the Low Copy Number method

8.8 Demonstration of new methodology applied to analysis of the Romanov family and remains of Anna Anderson *first demonstration of mitochondrial heteroplasmy – first demonstration of power of DNA profiling to resolve ancient DNA cases*

8.9 Development of all aspects of the national DNA database (analysis and interpretation requirements).

8.10 Development of the second generation multiplex SGM plus system , 2000

Development of low-tempate DNA analysis and associated statistical theory.

See Jobling and Gill(3) for a detailed review of the historical development of DNA profiling evidence

9. The existing UK framework

9.1 *The environment whereby revolutionary change could be captured and implemented no longer exists in the UK.*

9.2 Fragmentation of services, especially the devolvement of the national DNA database has proven detrimental in that the UK now lags behind the rest of Europe in the implementation of new multiplex systems.

9.3 I conclude therefore, for the UK to progress towards a successful research base for forensic science, the following are required:

a) Research must be integrated with the functions it exists to support. This is because research is of little value unless it can be moved quickly into casework.

b) New methods should be implemented by closely associated *'specialist casework'* unit that is to incorporate either new methods (e.g. RNA profiing) or to carry out rare, specialist casework tests

c) The UK must properly integrate itself into Europe. The ENFSI organization is especially important to facilitate this. ENFSI is composed entirely of non-commercial organisations. *except for the UK memberships.* We cannot function properly in isolation of the EU. The UK representatives cannot be fettered with commercial considerations as this raises concerns of conflict of interest and clashes with the European ethos.

d) It is especially important for the national DNA database to be integrated with the research group so that timely changes to the evolution of the national DNA databases may be made. *There are considerable doubts about the time-scales for introduction of new STR multiplex tests. This is a demonstrable examples where considerable research input is required to facilitate change.*

e) Good links with universities are of course essential (as the 1985 Jeffreys collaboration showed). But this simply demonstrates the importance of links and a framework to ensure rapid translation of discoveries in fundamental research into casework, facilitated by the research interface. These links don't need to be formal (e.g. Jeffreys collaboration), but scientists need to be well positioned (and encouraged) to respond to challenges.

f) Therefore the funding structure that is required is a centralised public body (centre of excellence), that is flexible enough to integrate with universities carrying out fundamental research, free from bureaucracy, and is easily able to access ring-fenced funding.

10. The importance of the research function in relation to the regulator function and the accreditation bodies

10.1 The complexity of forensic science is such that the research function must overlap with the regulator function and the accreditation function. This is because the complexity of new approaches (especially those that are based on complex interpretation algorithms) requires completely new approaches to quality assurance that are not currently used. I have argued

elsewhere[2] that the accreditation format is over-simplistic in its current format. When the environment is diversified, where multiple suppliers use different methods there is a requirement to carry out comparative studies to ensure that methods/processes comply with a standard that measure the likelihood of success –all tests carried out by suppliers should be comparable to each other.

10.2 Current accreditation systems ensure *compliance with a protocol* but do not test efficacy, or robustness of tests and they do not cross-compare different tests between suppliers. Within the forensic environment it is necessary to be assured that tests carried out between the suppliers are equivalent. To date there has been no externally published work that has been carried out to provide the necessary assurances.

11. The importance of the research function to respond to challenges from courts and other scientists

11.1 There is one very important aspect of the research function which is usually overlooked. The validation phase is never completed. Science is not static, but subject to continuous rapid change. We continually respond to challenges to existing methods as new understanding about processes and techniques emerge. It is important to respond rapidly to change. The researcher effectively retains overall responsibility. We must assume that there are weaknesses with every technique that is used in forensic science. The purpose of the court-going defence scientist is to point out weaknesses in techniques. It is highly important that that there is a feedback mechanism that ensures that additional research is carried out to address any relevant observations that are made by courts.

11.2 *Note: It is not unusual for the expert witness to be asked difficult questions. Defence experts may highlight valid concerns or issues that require research to properly resolve. It is never possible to anticipate all of the issues prior to implementation. There is a danger that expert witnesses are left unsupported if the framework cannot support collaborative work to resolve issues of common interest.*

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2 http://www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/writev/forensic/m19.htm

11.3 In the past this has operated effectively. For example Professor Balding (Imperial College) pointed out correctly(4) in 1994 that sub-population corrections were needed to ensure that strength of evidence was not prosecution biased. He also proposed a sampling correction. These ideas were readily adopted after discussion, but it was also necessary to carry out significant research to discover the extent of sub-population bias in UK populations.

11.4 There are many other examples – the most recent example relates to a challenge relating to the effect of linkage disequilibrium on two loci co-located on the same chromosome(5). *This particular challenge is being addressed at ENFSI level .*

11.5 All work is subject to publication and peer review as part of the normal scientific process.

11.6 To summarise:

a) A priori, we accept that no technique is perfect

b) We accept that all techniques must be subject to continuous improvement

c) We accept that challenge is a valid way to drive improvement, and concerns raised in court should be expedited and research projects initiated as required.

d) We concurrently address challenge by research, discussion, peer review by publication, and changing existing methods as required. Finally a review to ensure that past casework is not compromised is required.

e) Feedback to all suppliers and training is pre-requisite

f) It seems natural that this function falls within the public funded research facility that incorporates troubleshooting research to address specific court challenges, to make recommendations as a result of the research, to prepare peer reviewed reports, and finally to carry out the necessary training across all UK suppliers to ensure that there is consistency of court-reporting.

11.7 This is an additional argument for a centralised public research function, as the work must be carried out on behalf of the private

and public companies that provide forensic evidence. The kind of research required is often complex, and by definition we are probably working at the limits of our knowledge. Research projects of this nature are often urgent, because of court challenge, and rapid response is required in order to safeguard practice, to advise the regulator and assure reporting officers and the courts that the method that is in question is safe and fit for purpose.

11.8 There is an urgent need in the UK for a working group that is collaborative, focused on the practical issues, carries out joint experimentation, and is able to reach agreement on universal working practices and to publish in peer reviewed journals. A suitable model for was provided. A single paper was published in 2008, with national recommendations on advise LT-DNA interpretation (6), but unfortunately this was the only piece of work that was completed before dissolution. Nevertheless, the paper illustrates that it is possible to work together and to reach agreement on important issues that confront the UK forensic environment. It is natural that this working group should be coordinated by the research group, as it is inevitable that the complexities of some challenges will require significant research to resolve.

12. Importance of providing a framework that is not in danger of inherent prosecution bias

12.1 With increasing commercialization of forensic science services, where the police are the main customer, and with the prospect of accelerated introduction of police-owned laboratories there are serious issues relating to access of forensic science by defence experts. To bridge this gap it is proposed that the research/specialist casework unit exists to service all aspects of the CJS, including the defence scientist and barristers, lawyers and judges. Naturally, there will be a need to include defence scientists in training exercises in order to keep awareness of developments completely up to date.

12.2 The importance of this is self-evident. Notable mis-carriages of justice, including that of Sally Clarke where an (unchallenged) erroneous statistic was reported and the case of Barry George (convicted on the basis of a single speck of explosive powder) are both examples where simple errors were made by prosecution scientists. The absence of defence experts to point out the (elementary) errors led to wrongful convictions. The lack of

suitably qualified defence experts to capture these errors is a matter of public concern.

12.3 Consequently, to prevent future miscarriages of justice such as those outlined above, it is proposed that full consideration is given to encourage access in order to ensure that the framework that emerges supports all aspects of the CJS and is not inherently prosecution biased.

13. Conclusion

13.1 It is unfortunate that so much damage has already been done to the UK forensic environment, with little or no thought for the consequences. This paper attempts to describe the environment that existed prior to c.2000 because this was clearly a model that worked. It is to be hoped that the policy makers of 2011 show the same foresight as their forebears of the 1960s. The consequences of wrongful decisions will be felt for decades to come.

13.2 The purpose of this paper is to demonstrate the crucial importance of the *framework*. Research cannot be considered in isolation as it must be integrated within the framework in order to function correctly. It seems logical that the research' group' must be integrated into the hub. The hub must be public in order to avoid conflict of interest. It needs to be well funded, proactive, and associated with a specialist casework unit, integrated with the national DNA database. It does not need to be a large group, but it essential that the staff must be of the highest calibre.

13.3 The centralized research function will support all aspects of the CJS. In particular apart from carrying out research, it will support the regulator, support accreditation programmes and support training initiatives.

14. LIST OF RECOMMENDATIONS

Recommendation 1: The UK reforms a well-funded centralised research laboratory along the lines of the Home Office Central Research and Support Establishment (CRSE). This laboratory should also have access to funds sufficient to carry out collaborative work with universities, the regulator and the accreditation bodies

Recommendation 2: The centralised research laboratory should operate on a non-profit making basis and should make its research freely available to both private and public forensic caseworking

laboratories. The development of open-source solutions is needed to drive best practice and uniformity between laboratories. To avoid conflict of interest, it is clear that the central research function should be public and unfettered by commercial interest.

Recommendation 3 The national DNA database should be integrated with the research group so that:

a) Upgrades to the database can be made in line the EU recommendations
b) Additional databases can be constructed e.g. Y chromosome database
c) Frequency databases can be constructed in order to test strength of evidence
d) Error rates (false inclusion and false exclusion rates) are researched and published
e) New software strategies are explored and implemented
f) Troubleshooting is efficiently carried out
g) Continuous improvement is encouraged
h) Devise new ways to cross-compare multiplexes from different suppliers and to assess problems of non-concordance, devising solutions as required.

Recommendation 4: The public research function needs to integrated with a casework unit that operates closely with the research group. This combined effort will ensure that new techniques can be rapidly implemented. Often it will not be cost effective for private companies to spend money developing tests that are rarely used. It is obvious that a publicly funded casework facility is required to implement/carry out the tests.

UK is already falling badly behind with implementation of new methods such as: new multiplex to replace SGMplus; implementation of new RNA markers for body fluid identification; Laser micro dissection to pick individual cells for DNA analysis.

Recommendation 5: The research function needs to be closely integrated with the regulator and accreditation bodies so that new methodology can be used to make comparability studies across suppliers. This will provide the courts confidence that tests are equivalent across suppliers

Recommendation 6: A comprehensive training programme is required in order to keep forensic scientists up to date with developments, and

to keep in line with ENFSI/EDNAP/ISFG recommendations. The research group would be closely associated with this function.

Recommendation 7: Research/casework interface also works closely with defence scientists in order to ensure that the CJS does not become depleted – (defence scientists provide a crucial balance/ quality-check - the concern is that there are insufficient to support the CJS). As police laboratories become prevalent in the 'market-place' it is likely that this position will be exacerbated.

Recommendation 8: The research group adopts responsibility to coordinate working group activities and organise collaborative experiments between the laboratories (analogous to a national EDNAP – a parallel is the German GEDNAP group). This group actively collaborates to solve scientific problems that are common to all suppliers and enagages in continuous improvement activities.

Recommendation 9: The research group supports the CJS and must be positioned as an unbiased, neutral entity. As such it must be proactive in supporting the defence scientist, Barristers, Lawyers and Judges by providing access to facilities and training, and by addressing concerns raised by defence scientists and courts to ensure that techniques and methods are robust. A continuous improvement strategy is followed. The aim is to prevent elementary errors leading to convictions, typified by the cases of Sally Clarke and Barry George.

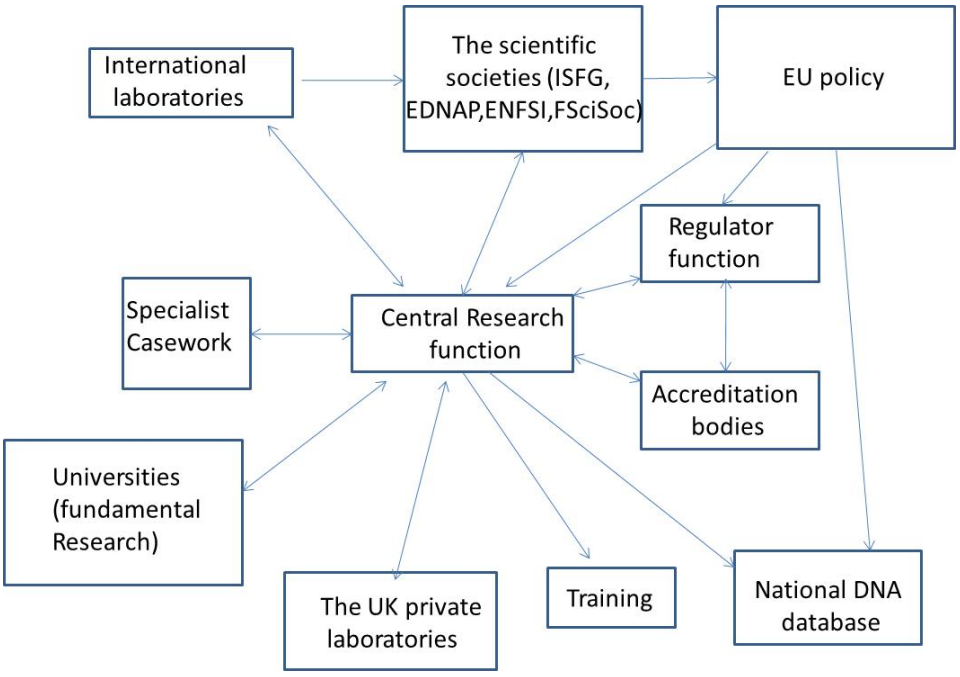

Fig 1: A diagram of a proposed structure for forensic science within the UK

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DR KARL HARRISON, CRANFIELD UNIVERSITY

I have recently been asked to comment on a letter circulated to all heads of university forensic science departments regarding the level of forensic science research, the success in translation of that research into industry and the level of success at attracting funding to support this research.

My detailed comments will form part of Cranfield University's response, but I had a personal view on the difficulties within forensic science, and a fairly clear idea for a solution. As with most clear ideas, there are probably very good structural reasons why it won't work, but I thought it should stand or fall on its own merits - hence this email.

Levels of research in my department are good - certainly in comparison to teaching universities I've worked in, but even here, translation is a constant problem, as academics fail to understand the needs of forensic service providers, the conservatism of police forces as a customer market or the problems caused by innovation in dealing with the courts. Very few forensic academics have a developed understanding of industrial science, let alone recent developments in forensic service provision.

In addition, there is little incentive for forensic service providers to engage with universities - indeed, the requirement to publish under the RAE/REF has a tendency to make providers rather nervous. In addition, very few senior scientists at management grades have long-standing or meaningful links with university departments, resulting in a cultural gap between the two sectors.

These faultlines are further compounded by that between police-employed Crime Scene Investigators and forensic service providers. Again, due to cultural differences, CSIs have tended to regard themselves as a trade, rather than a scientific profession (and large numbers of BSc and MSc graduates being recruited into these roles does not appear to have altered this conviction) - consequently they are generally unhappy to invest in their own development, join professional societies or become involved in research. The needs of the CSI, or their effect in handling evidence that marks the beginning of the scientific data gathering for forensic scientists later in the process are rarely questioned or considered. In conclusion, police forces as represented by their Scientific Support Departments currently are currently tenuous stakeholders at best in the greater process of forensic science provision.

I've worked as a CSI, a lead scientist with a private forensic service provider, a forensic science academic and an independent consulting expert, so I've had the opportunity to see the dilemma from a number of angles.

The solution I would like to suggest is that research themes be identified by central government, supported and advised by an advisory panel on forensic science. A number of 3/4/5 year resarch goals and deliverable waypoints can be identified within the themes, as identified by police stakeholders, forensic service providers and forensic academics. These themes are then divided into groups to mirror the current biddable lots distributed to tender to forensic

service providers. These lots represent significant revenue for private forensic service providers (potentially moreso than ever, should the FSS disappear).

By linking research themes and goals to tendered lots, forensic service providers are required to take on a degree of responsibility for ongoing research and development on that area, with an earmarked percentage of investment expected by government if the company are to compete in the tender framework again - perhaps in the region of 5%; so if a major FSP wins regional drugs work thought to value in the region of £1m over the course of a year, they also accept a requirement to invest £50k to meet the identified research needs in drugs analysis research.

Whilst FSPs tend to have vestigial research and development departments, they are not set up to deal with major research projects, so the understanding would be that the earmarked research funds would be invested in a university partner who can establish programmes of research to address centrally-identified needs via funding already held within private companies.

There would seem to be a number of advantages to this:
- Net funding of forensic science research would increase without burdening research councils.
- Forensic science research would immediately become applied and relevant, dealing with any issues regarding difficulties in translation of technologies or processes.
- Research councils would no longer need to worry about predicting impact of research statements prior to funding, as the scrutiny of private investors would ensure taregted research and value for money.
- Partnerships between FSPs and universities would natually develop, resulting in a small core of well-funded, research-active departments - a goal outlined by Vince Cable.
- The culture gap between provider-based forensic scientists and university-based forensic academics would be bridged in a very short period of time.
- Police forces as ultimate stakeholders in the requirements of forensic science gain a voice in the setting of research aims, and in the commission of a particular FSP.
- FSPs gain access to valuable research facilities that can be directed to improving their business through new IP, improved processes, quicker/cheaper turnarounds, etc.

It seems elegant, so I am in no doubt there must be distinct problems with the idea I know nothing of. Many thanks for your time nontheless.

INDIVIDUAL RESPONSE: DR KEVIN SULLIVAN

Introduction

1.1 I am writing in the capacity of a private individual, but also from a position of some knowledge, with over 23 years of experience in forensic research and standards in the UK, including as Head of R&D, and latterly the Standards and Validation Manager, for the FSS.

1.2 This submission concentrates on what needs to be done if this country is to retain its future capability and worldwide standing in forensic science, following the ministerial decision to wind down and close the FSS. This decision presents a major opportunity to re-organise and improve the way that forensic advances are developed and implemented to the benefit of the Criminal Justice System as a whole.

2 The Impact on R&D of the Ministerial Decision

2.1 The FSS are and have been for decades the key provider of forensic R&D and new groundbreaking techniques in the UK, and a major contributor on a global scale of which our country can be justifiably proud. It has also been pre-eminent in the development and improvement of standards for forensic science worldwide. It is imperative that this work be allowed to continue, but no other organisation in the UK has the capability to do so: university departments have a principal contribution to make in undertaking fundamental research which can be adapted to forensic applications but lack the in-depth experience of taking ideas through from concept to a rugged and validated process that can withstand the rigours of our adversarial judicial process; police labs lack both the necessary environment and the critical mass of research staff required to undertake substantial research projects; there is no government research capability in this area, the closest being the Home Office Police Scientific Development Branch which lacks DNA capability and experience. Despite the world-renowned reputation and track-record of FSS R&D for innovation and delivery, other commercial companies are unlikely to be able to absorb these staff or their work as an overhead in an increasingly competitive and shrinking commercial market.

2.2 Loss of these R&D and other core activities will result in the UK world lead in this area being lost, new types of forensic evidence will not become available to the CJS and some specialist forensic applications will cease to exist. In addition, capability to respond to continually evolving challenges to scientific evidence in courts will be degraded by the irreplaceable loss of expertise. As the Director of the Forensic Science Laboratory Republic of Ireland put it, “The closure of the FSS will mean there will be no mother ship”[1].

3 The Most Effective Solution for the Future

3.1 In my opinion, the most effective way to safeguard the aforementioned capabilities would be to move personnel within the FSS R&D team back into a publically funded entity. This group has the expertise, critical mass and cross-functional skills necessary to deliver substantial technical improvements to forensic provision. Currently the group has significant momentum in the development and implementation of a number of key projects including DNA expert systems, probabilistic analysis of fingerprints, the validation and introduction of enhanced performance DNA chemistries, plus rapid DNA analysis. Decisive and early action is required if this is to be preserved, otherwise the key resource which is the highly skilled workforce will inevitably be dissipated as these experts move elsewhere due to impending job losses.

3.2 No other country in the world has attempted to meet its forensic requirements on a purely commercial basis, not even in the USA where commercial laboratories have been established the longest: the Americans have always recognised that the long-term health and viability of their CJS is reliant on state-owned provision to cover complex and commercially unattractive elements of the whole forensic offering that private companies cannot provide. These include core R&D activities plus development and maintenance of forensic databases and standards which are provided by centrally funded Federal Laboratories and Agencies, including the FBI and the National Institute of Science and Technology. In addition to these agencies the US National Academy of Science recently recommended establishing a National Institute for Forensic Science to establish and progress the field within their country. Professors Jeffreys[2] and Caddy[3] amongst others have emphasised the need to establish similar centralised capability in the UK. Given the turmoil in UK forensic science caused by experimenting with fully commercial forensic provision, this advice should be heeded rather than existing problems compounded by attempting to deliver these essential R&D activities in novel and unproven ways.

3.3 An effective centrally funded core facility would have the following characteristics and benefits:

- Operate to a principle objective of maximising the utility of forensic science in the UK Criminal Justice System
- Be of sufficient size (“Critical-mass”) and have the appropriate blend of skills and experience to be able to undertake a substantive portfolio of research and development that delivers products/services on behalf of all stakeholders in the CJS. The latter could include for example the following:
    - Provision of expert systems software
    - Training for police and other Forensic Science Providers (FSPs) both in the UK and internationally
    - Consultancy, and high-end casework capability including counter-terrorism work
    - Provision of QA trials and other quality assurance services in support of police force accreditation to ISO17025
- Operate on a not-for-profit basis for the “greater good”, thereby minimising barriers to introducing innovation into the wider CJS

- Provide value to taxpayers by recouping costs where possible through charging mechanisms for certain of the aforementioned services
- Undertake horizon scanning and contribute to government policy on forensic science and other Criminal Justice matters in the UK
- Be responsible for the technical development and future direction of the UK National DNA Database and for maximising the utility of associated technologies, which will be revolutionised over the next decade
- Have close affiliation with the Forensic Science Regulator, providing a focal point for standards development, technical advice and practical scientific support
- Develop and manage national forensic data collections
- Establish and maintain synergistic collaborations with networks of other organisations within the UK and internationally, to progress R&D and related activities in the most cost-effective and productive way for the UK, including by leveraging grants and other financial support from all available sources

3.4 Prior to the FSS becoming a Government Agency, it operated as a virtual FSP monopoly and its R&D activity was undertaken at the Home Office Central Research and Support Establishment, a discrete entity within the FSS. A return to the Home Office as part of their Science and Research Group merits careful consideration: this would offer significant synergy and complementarity between two groups' current capabilities and research mandates.

4 Conclusions

There is a real opportunity for the government to improve the way new techniques and other core elements of forensic science are delivered and supported in the criminal justice system as a whole, through strategic merging of existing capabilities that do not fit within the commercial remit of forensic science provision, into a world-leading, innovative entity that works to the highest quality standards. Technological innovation would be made widely available to improve the quality and efficiency of forensic science nationally and increase resilience to evolving challenges within the judicial system.

Dr Kevin Sullivan
Standards and Validation Manager for the FSS
21st March 2011

References

1-3: Written evidence submitted to the House of Commons Science and Technology Committee Review of the Forensic Science Service by Dr Sheila Willis, Professor Sir Alec Jeffreys, and Professor Brian Caddy respectively.

PROFESSOR WESLEY VERNON OBE

1. What work relevant to forensic science is being done in your group/university and what are the opportunities for the future?

In my specific area of forensic podiatry, we struggle to find appropriate sources of research funding and most research taking place is self-funded and therefore very limited. Given that we believe that our professional practise in forensic podiatry should be evidence-based, these limitations hold back our practise development considerably.

2. What previous and current research partnerships do you have with forensic science providers, police forces, the National Policing Improvement Agency, etc.?

No formal research partnerships exist (but could do to mutual benefit, especially through the NPIA)

3. Can you give good examples in the forensic science field of translation of research into practice, and also any examples where this has been difficult or problematic?

In my own field:

A) Shoe outsole wear research, in which myths of the past in relation to outsole wear interpretation were exposed and a new explanatory model introduced in place of these.

Difficulties in adopting the research findings related to scepticism from some older forensic practitioners in related disciplines, who simply ignored the research findings and carried on with past methods.

B) Bare footprint research in which a new model to validate new approach to bare footprint analysis is just starting to be introduced into practise (through an instructional handbook).

As above, difficulties in adopting the research findings related to scepticism from some older forensic practitioners in related disciplines, who simply ignored the research findings and carried on with past methods.

C) A model to assess the suitability of CCTV images for forensic gait analysis.

No particular problems have been experienced to date although the presented research is quite recent.

4. What do you see as the opportunities for, and the barriers to, the funding of research relevant to forensic science?

Opportunities exist in relation to some of the more recently founded disciplines to help them to establish quicker and thereby, to be able to better assist the criminal justice system and quickly eliminate the potential for erroneous work in the pioneering stages of such new disciplines.

Barriers exist in relation to funding accessibility, especially where these new disciplines are not yet fully understood by the forensic science establishment.

5. What are the important international networks and how useful are they? Do you have any specific international collaborations you would wish to draw to our attention?

We are aware of and use the following:

A) The International Association for Identification (IAI) in the - USA: We have collaborated closely with the IAI in the development of our own speciality. Similar issues are being faced in the USA and we find that through this collaboration, developments in one country can be utilised by other countries involved, thereby bringing practises in line internationally.

6. Are there any other issues relevant to our terms of reference that you would wish to comment on?

No other than the review is welcomed and we hope that due coverage is given to helping new, pioneering disciplines to better access R & D funding for the wider benefit.