Fingerprinting – the UK Landscape: Processes, Stakeholders and Interactions

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Forensic Science

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Executive Summary

The aim of this report is to provide a current view of the landscape of the fingerprinting domain, within the United Kingdom. This report will identify the key stakeholders, within UK fingerprinting, and determine the current channels of communication, knowledge transfer, and innovation across the UK by delivering the following elements:

- A description of the history of fingerprinting in the forensic domain, and the process followed during the recovery and comparison of fingerprint evidence;
- A summary of the key stakeholders influencing this process;
- A description of the role of these key stakeholders within the fingerprint domain including:
  - ◊ The role of policing stakeholders;
  - ◊ The role of training and accreditation bodies;
- Current fingerprint research and development;
- A number of case studies illustrating examples of knowledge transfer between stakeholders and innovation within the fingerprinting domain; and
- Gap analysis leading to recommendations for the Forensic Science Special Interest Group to facilitate increased communication and innovation in this domain

This report has been compiled following consultation with a number of specialists within UK fingerprinting. However, it is acknowledged that this report does not represent the views of all contributors and that there are often differences of opinion and local alternatives to structures and procedures, which mean that the information contained within this report should be taken as a guide only. This report has been published to allow further consultation within the fingerprint community.

Terminology specific to the fingerprint domain included within the report is defined in the glossary of domain specific terms at the back of the document. Further, there are additional terms listed in the glossary that are not directly referred to in the main body of the text, but may be of benefit to those unfamiliar with fingerprinting terminology.

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1. Introduction

1.1 Aims and Scope

This report aims to provide a current account of the fingerprinting landscape within the United Kingdom that will be of benefit and interest to:

- Fingerprint practitioners and operational management; and
- A lay audience of external innovators.

The report documents the current fingerprinting landscape in a factual manner, mapping the taking of fingerprints in order to establish identity as well as the progression of fingermark evidence from crime scene to court, documenting and describing the key stakeholders influencing this process, and detailing the communication and knowledge transfer that occurs within UK fingerprinting. In addition, the report also provides case studies of innovation and interactions along with more subjective recommendations and comments.

The scope of this document is primarily limited to the police force-based processes for the production of fingerprint evidence within the UK Criminal Justice System, rather than the wider forensic use of fingerprints (border control, customs, visas, and intelligence and defence applications). However, the report acknowledges that further work on this 'landscape' would be beneficial to external innovators.

This report is intended to be the starting point for discussion and further input will comprehensively map the fingerprinting community. Whilst the authors have made every effort to provide a comprehensive guide to UK fingerprinting, it is acknowledged that we cannot provide an exhaustive list of fingerprinting stakeholders or current research.

1.2 Methodology

This report has been produced through a combination of discussion and interviews with stakeholders from a number of different domains within the fingerprinting community, the tacit knowledge and experience of the contributing authors, and through desk research.

Authorship of the report has been split between three co-authors, chosen for their varied experience and backgrounds. The diversity of the authors' experiences ensures that the report is neither fingermark development nor fingerprint interpretation centric, but covers both of these aspects of the fingerprinting process equally. Author profiles are provided in Chapter 8.

A full list of contributing stakeholders is also provided in Chapter 8.

2. Introduction to Fingerprinting

2.1 A brief history of fingerprinting

For over 100 years, fingerprints have been used in the UK for the purposes of human identification within the Criminal Justice System. Indeed, fingerprinting was the first form of reliable identification evidence and is still the most widely used in the UK. Other identification science such as DNA can individualise to a point, but only fingerprints can discriminate between close familial connections such as identical twins. Fingerprint identification techniques utilise technologies that are both relatively inexpensive to use and can provide results in seconds to the end user.

The principles associated with fingerprint identification were established in the late 1800s and the first UK bureau set up in Scotland Yard in 1901 by Sir Edward Henry; the Police Commissioner at that time. It is still the case that fingerprint visualisation, recovery and comparison is largely a function conducted by police forces in the UK, rather than privately owned forensic service providers.

The identification of persons by means of fingerprints involves the comparison of marks deposited by uncontrolled contacts at crime scenes, with prints taken under controlled circumstances and stored on a database or maintained as paper records. There are several stages involved in reporting an identification, which will all support and corroborate the circumstances surrounding a criminal investigation; the detection of crime scene latent fingerprints, enhancement of fingerprints, imaging of fingerprints, transmission of fingerprints, comparison of marks, reporting of conclusions as well as the context in which such material is located. The exact methodology employed by examiners is known as 'ACE – V', whereby the examiner will follow a process of analysis, comparison and evaluation followed by a verification process, before a report is issued to investigators.

Comparing a fingerprint against a catalogue of known individuals, may have taken weeks or even months by dedicated human examiners as little as 30 years ago. This can now be conducted using technology, such as automated fingerprint matchers, in a matter of seconds. A key challenge for fingerprinting in the modern age, and, indeed, for other methods of human identification, is to reduce the time and cost of the process, whilst maintaining the speedy notification of intelligence to aid an investigation and maintain evidential quality.

For a more comprehensive history of the use of fingerprints please refer to the bibliography in the appendix to this publication.

2.2 What is a Fingerprint?

A fingerprint is made up of friction ridge skin that has fractures and interruptions within the structure known as Galton details, (also known as ridge characteristics or minutiae).

It is these characteristics (see **Figure 1**) that, when visible to the fingerprint examiner, enable a determination of individualisation of a crime scene fingermark against the ten-print card (the collection of all ten finger and thumb prints of an individual, often also including their palm prints) of a person of interest in the case. The person of interest may be a suspect, but may also be a person who requires exclusion or elimination. There are two primary classifications of the characteristics to be found, namely, ridge endings (**A**), where ridges stop abruptly, and bifurcations, where a ridge divides into two (**B**).

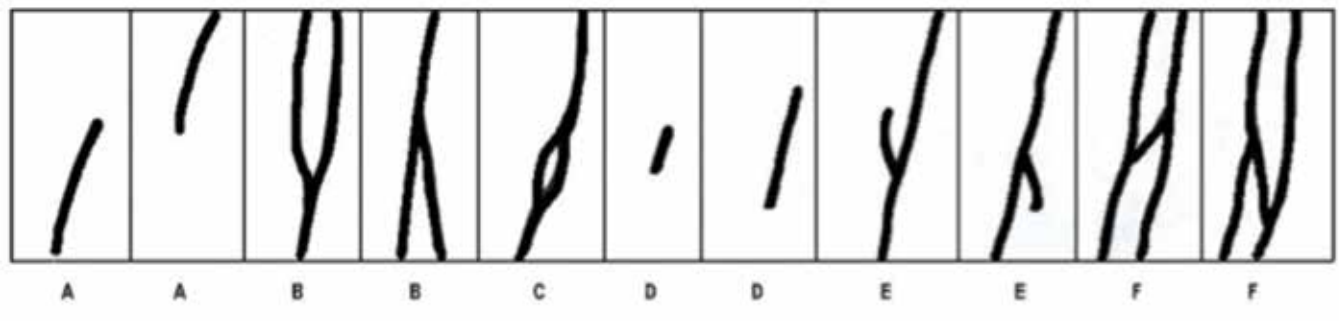

Figure 1– Types of fingerprint ridge detail (courtesy of the College of Policing, previously NPIA Training School).

There are variations on the theme for these primary characteristics. For example:

- A lake is where two bifurcations join together (**C**)
- An independent ridge is a short ridge that is divorced from any other ridge (**D**)
- A spur (**E**) is a combination of a small independent ridge and a bifurcation
- A crossover (**F**), as the name suggest, is a small ridge joined at each end to two parallel ridges.

Fingerprint examiners (who are responsible for carrying out comparisons between fingermarks, recovered from crime scenes and fingerprints taken from persons of interest in the case) should assess holistically all features within a fingerprint from which to make conclusions as to identity. These features are broken down into three levels of detail (see **Figure 2**). Level one refers to the basic pattern of the print, level two refers to the Galton details described earlier, and level three refers to the configuration of sweat pores and shapes of the ridge edges.

1st Level **2nd Level** **3rd Level**

Figure 2 – Levels of ridge detail within a fingerprint (courtesy of the College of Policing, previously NPIA Training School).

2.3 Properties of friction ridge skin

Whether a fingermark is deposited accidentally at a crime scene, or whether a fingerprint is taken under controlled conditions from a donor, it is the nature of friction ridge skin contained within the deposit that makes it an ideal medium from which to individualise a person. Fingerprints are considered both unique and permanent due to the mechanism of friction ridge skin formation in the womb. To date, no friction ridge skin has been found to have changed between birth and death. The only exception to this could be a case of a deep-seated injury to a sub-dermal level of the skin structure. In such an instance, scarring may subtly change the appearance and flow of the friction ridges. Friction ridges have regenerating properties at skin cell level. However, there are a number of skin diseases that could permanently affect friction ridge appearance and also professions, such as bricklaying and other manual work, which could impact upon the quality of visible ridge features within a person's fingerprint.

2.4 Fingermark (Including Palm) Deposition:

A latent fingermark is deposited when an area of friction ridge skin comes into contact with a surface causing the transfer of the constituents present along the ridges of the skin to the surface in question. This 'latent' fingermark is not readily visible and may require physical or chemical enhancement in order for a representation of the fingermark to be recovered that can be used for comparison purposes. 'Patent' fingermarks are those that are deposited in a visible contaminant such as blood or dirt. These marks are often more readily visible, but still may require some enhancement. In addition fingermark impressions may be left in a soft surface such as wet paint or putty.

Latent fingermarks are composed of the natural secretions found within human sweat and environmental contaminants that will adhere to the surface of the hand (dirt and grease etc.). The sweat is predominately composed of water, but also contains highly complex water-soluble organic and inorganic materials, including amino acids.

Knowledge of the constituents likely to be present within a fingermark, and the factors that can affect their distribution and persistence, allow the development of novel and innovative techniques to visualise latent fingermarks. These will include specific chemical enhancement techniques as well as the use of light sources and digital capture techniques to aid visualisation of fingermarks deposited at a crime scene.

2.5 Fingerprints Taken Under Controlled Conditions

Fingerprints can be taken from donors in a controlled environment using a combination of digital capture using scanning technology (such as live-scan) in a custody suite, for example, or can be recovered using the more traditional methods of ink and paper, such as in the recovery of elimination fingerprints from a victim of crime. In taking prints in controlled conditions, it is possible to recover far more detail within the fingers and palms and to include all areas of potential interest within a fingerprint to enable a full comparison against the fingermarks recovered from crime scenes. Fingerprints recovered in this way can result from donation under the Police and Criminal Evidence Act (PACE) legislation from suspects of criminal activity, or from members of the public who may donate prints to facilitate elimination against marks recovered from a crime scene. It should be noted that the taking of any prints in connection with a criminal investigation is covered by PACE including prints given voluntarily or with consent. More recently, fingerprints taken under controlled conditions may also facilitate criminal records checks for those working with children or vulnerable persons as well as general biometric vetting for new staff entering specific professions where security checks are necessary.

2.6 Current Issues and Challenges to the Acceptance of Fingerprint Evidence: The Need for Innovation

Fingerprint identification has come under scrutiny in recent years (for further information see Cole, McKie, Fingerprint Inquiry Scotland and Dror in the further reading appendix to this report). Challenges to the validity of fingerprinting as a forensic tool and the way in which such evidence should be accepted by and presented to the courts and the wider criminal justice system has, in part, resulted from the perception that human error in the profession has yet to be evaluated and quantified. Erroneous identifications (and missed identifications) have led to recognition by forensic practitioners, academia and the wider justice system that fingerprint examination is a subjective, opinion based practice. This, to one degree or other, is influenced by cognitive human traits, including contextual bias and priming as well as perceptual weaknesses in the human practitioner. This is not to say that human practitioners are not good at what they do; in fact expert practitioners are proven to be highly reliable in their performance. However, technology can and should be harnessed to support the work they do and to perform certain cognitive tasks where technology may be better suited to the task in hand. This may improve overall accuracy and reliability of the process and provide reassurances to the public and wider justice system.

Below is a case example where a misidentification occurred:

Shirley McKie (a Police Officer) was arrested for perjury for stating under oath during a murder trial that a mark, which was matched to her thumb during routine elimination checks, was in fact not hers. Latent print examiners from other agencies around the world challenged the validity of the identification and after multiple investigations and a public inquiry into the events surrounding this incident; McKie was vindicated when the original match was ruled as a misidentification. This case probably represents one of the most detailed and deepest assessments globally of the state of fingerprint analysis. The judicial inquiry resulted in many recommendations on the future of fingerprint science, and the processes and procedures that needed to be introduced to improve the safety and reliability of the evidence provided (Fingerprint Inquiry Scotland 2011).

Key recommendations within the Inquiry:

1. *Fingerprint evidence should be recognised as opinion evidence and not fact. Those involved in the criminal justice system need to assess it as such on its merits.*
2. *Examiners should discontinue reporting conclusions on identification or exclusion with a claim to 100% certainty or on any other basis suggesting that fingerprint evidence is infallible.*
3. *Examiners should receive training which emphasises that their findings are based on personal opinion; and that this opinion is influenced by the quality of the materials that are examined, their ability to observe detail in mark and print reliably, the subjective interpretation of observed characteristics, and the cogency of explanations for any differences and the subjective view of 'sufficiency'.*
4. *Differences of opinion between examiners should not be referred to as 'disputes'.*
5. *The Standard Operating Procedures of the Scottish Police Services Authority should set out in detail the ACE-V process that is to be followed. I should explain here that ACE-V is an acronym for analyse, compare, evaluate, verify and is a process that fingerprint examiners are encouraged to follow.*
6. *Features on which examiners rely should be demonstrable to a lay person with normal eyesight as observable in the mark.*
7. *Explanations for any differences between a mark and a print require to be cogent if a finding of identification is to be made.*
8. *A finding of identification should not be made if there is an unexplained difference between a mark and a print.*
9. *The Scottish Police Services Authority should develop a process to ensure that complex marks (such as Y7 and QI2 Ross) are treated differently. The examination should be undertaken by three suitably qualified examiners who reach their conclusion independently and make notes at each stage of their examination. The substantive basis for the examiners' conclusions should be reviewed. The reasons why they have reached their respective conclusions should be explored and recorded, even where they agree that an identification can be made.*
10. *An emphasis needs to be placed on the importance not only of learning and practising the methodology of fingerprint work, but also of engaging with members of the academic community working in the field.*

Displaying grave dissatisfaction with police-dominated latent fingerprint identification practices in England and Wales, the Court of Appeal in R. v. Smith, [2011] EWCA Crim 1296, quashed a murder conviction. Initially the examiner had concluded that there was insufficient detail for a meaningful comparison. After he learned that a suspect had been charged with the murder, the examiner re-examined the evidence with the aid of "a new scanning and printing machine which enabled him to run the print off and compare print to print more easily." He "concluded that the ridge flow and 12 ridge characteristics could now be identified with the fingerprint from the suspect's left forefinger." His report simply stated that "In forming my opinion I have considered the amount of detail, its relative position and sequence and general quality. I have no doubt that the area of friction ridge detail indicated in the photograph was made by [the suspect]." He made "no working notes" because "he did a continuous analysis and his working notes were in effect the photographs." Two officers in the same police department verified the identification without meaningful documentation.

At trial, the three fingerprint officers testified to the identification. A defence expert testified—"that he had never seen a fingerprint officer identify a print of such poor quality." But at the last minute, the defence choose not to have its principal expert testify because the Crown planned to attack her qualifications and work in other cases. She described herself as being qualified because she had trained "in Modern Fingerprint Technology," had "successfully completed the Advanced Latent Fingerprint Course with Metro Dade Police, Florida, USA," and was "an active member of the International Association of Identification."

The appellate court heard testimony from two retired police fingerprint examiners. They proposed that the Crown's examiners had confused furrows with ridges and that they had ignored a part of the image that excluded the defendant as the source of the bloody print. The original examiner advanced what appeared to be a post hoc theory that the defendant had touched the door handle twice and that this explained why the defence analysts had a different interpretation of the part of the print on which he had relied for his identification.

In a future under ISO 17025 whereby the recording of how decisions were made in an efficient and contemporaneous manner will be important innovation into the presentation of complex fingerprint decisions in a courtroom (or via Streamlined Forensic Reporting) is an area where improvement is needed.

Other challenges facing fingerprint examination include the potential introduction of probabilistic assessments of fingerprint evidence similar to the way DNA evidence is analysed and presented in the courts. The challenge in developing probabilistic tools is to accurately replicate the ability to assign a probabilistic value to the identification conclusion using holistic information within the fingerprint. At this time probabilistic models exist but rely upon limited information within the friction ridge skin (primarily the pattern and ridge flow) and do not take into account the many other features within a fingerprint that examiners use to establish either identification or exclusion. This is hindering wider acceptance of the principles of probabilistic evidence being accepted by practitioners. However, this issue does provide a great opportunity for innovation partners to provide solutions to these problems.

It is crucial that innovators have a sound knowledge of the landscape of fingerprinting and are aware that any future technology must be sufficiently robust to stand up to tough scrutiny in a court of law as well as satisfy the scrutiny of validation under future ISO 17025 accreditation which is expected to be introduced for fingerprint bureaux in the UK in 2018. ISO 17025 will require both the accreditation of the practitioners through competency and proficiency testing, as well as the calibration and validation of any processes (including technology) that are introduced into the fingerprint domain.

3 The Fingerprinting Process: Crime Scene to Court

3.1 Fingerprint Evidence: Processes, Stakeholders, and Influences

The diagram presented in **Figure 3** has been produced to map the core process of fingerprinting from crime scene to court.

This diagram illustrates the standard progression of fingerprint evidence within the criminal justice system, from the point that a crime is committed to the judicial outcome of the criminal case. The core process of the generation and production of fingerprint evidence is illustrated within the pale blue boxes in the centre of the diagram. These follow a chronological chain of events from the crime scene, through the laboratory and the fingerprint bureau, into the courtroom. The stages detail the processes of recovery, recording and comparing of fingermarks.

The diagram illustrates a number of the main external influences on this core process. Influences upon the entire process from crime scene to court are shown at the top of the diagram, while those relating to either the fingerprint laboratory or the fingerprint bureau in isolation, are given at the respective sides of the diagram. External influences upon particular stages in the process are indicated with arrows connecting them to the aspect of the process that they influence and displaying the directionality of this influence. All external influences are colour coded to relate to one of four categories of stakeholder (to be further discussed in Chapter 4) – training, accreditation and regulation; policing; academia; and industry.

It should be noted that this diagram represents an approximation of the fingerprint evidential process and, as each UK police force will have different policies, procedures, and working practices, there may well be local variation in this process.

The introduction of Forensic Streamlined Reporting (SFR) has had a dramatic effect on the reduction in the amount of cases where full evidential statements are required. Of note for innovators is the way the SFR process may generate questions arising from the defence in relation to orientation and positioning of marks, or age of fingerprints left at a scene. Such questions, and others, should be considered as important areas where innovation is needed.

FINGERPRINT EVIDENCE PROCESSES, STAKEHOLDERS AND INFLUENCES
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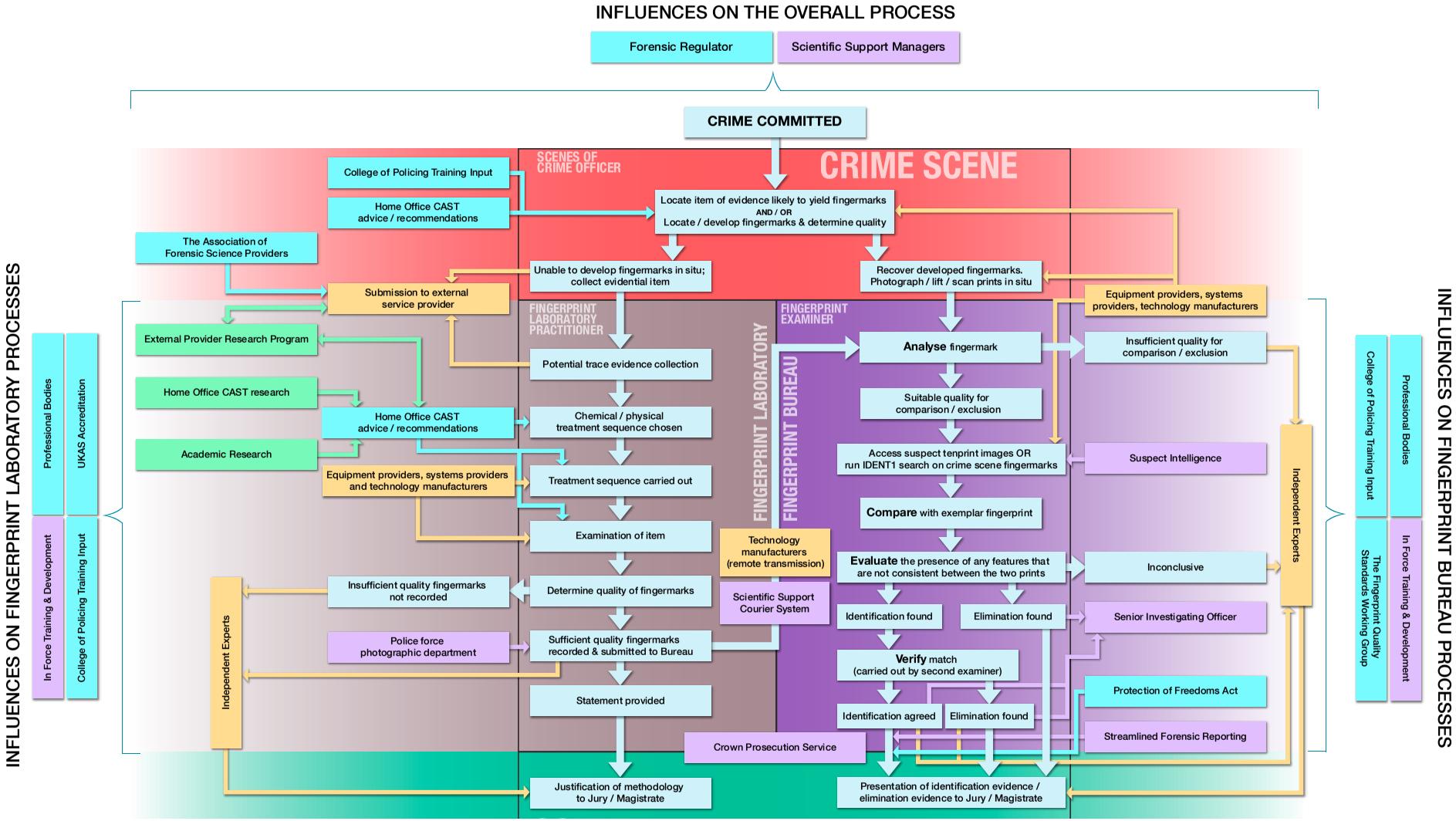

Figure 3 - The process diagram - Fingerprint evidence: processes, stakeholders, and influences

3.2 The increasing importance of technology within the fingerprinting process

From the crime scene to the courtroom, technology is now changing the nature of the human contribution to the assessment of fingerprint evidence. New technologies continue to impact and encroach upon the traditional human cognitive process, sometimes taking over such functions altogether. In considering the impact of technology on the evidential journey it should not be forgotten that the custody process from the moment a suspect becomes known to investigators is also subject to technological influence. Whether it be roadside checks using digital fingerprint devices to ascertain identity, or whether it be the digital capture of ten-prints within the custody charging centres; Livescan and Mobile ID devices are now becoming more portable, easier to use, as well as more efficient and time saving. The use of ink and paper is largely a thing of the past and even the current digital technology is beginning to look 'old hat' against new technologies that no longer require direct contact between the donor and the recording device (ultrasonic fingerprint readers).

Technology will have a different impact dependent upon where in the judicial process it is applied to support fingerprint evidence. For example at the crime scene, CSIs will need to both locate and assess fingerprint evidence. There have been varying degrees of success in developing technology to better enhance fingerprints at crime scenes, to remotely capture and transmit them using digital devices, as well as 'app' technology for recording actions at crime scenes and for recording contemporaneous notes. All of these developments are aimed at both enhancing the evidential product, that is to say recovering better quality fingerprints, as well as to speed up processing time and to make forensic service provision more cost effective, leading to the most efficient evidence for the courts.

Within the laboratory, there are similar challenges to provide a leaner, more efficient service. The chemical treatment and enhancement of fingerprints requires specialist light sources, processing equipment such as vacuum chambers and superglue ovens. Such equipment facilitates the bulk processing of exhibits and speeds up the evidential journey. As early adopters of more exacting quality standards related to ISO17025 (see section 4.2.4), not only have these laboratories been required to develop 'scientifically validated' equipment and consumables, they will also be required to demonstrate that technology can also stand up to exacting quality assurance requirements, in addition to providing proficiency testing of practitioners within the environment.

One of the major challenges in the next few years is to develop standardised technology in the domain of digital imaging. Whether it is camera equipment for storage and retrieval, case management systems, or the use of digitised forensic material, such technology must be designed to facilitate easy search and retrieval of evidential material, as well as be able to consider weeding and retention requirements around data protection, the protection of freedoms act (POFA) and Schengen legislation[1]. Fingerprint visualisation will be important as bureaux move to more paperless working practices and future AFIS technology and remote transmission systems must be capable of working to integrated protocols that consider standardised image display requirements. It is considered essential that there are uniform standards for image display of fingerprints. Future paperless working may require higher standards than the current 500 ppi considered the norm in the UK at this time. Paperless working is important not only because of the consumable costs it saves, but also because of the quality of image presented to the examiner. Digital printing technology is not able to output 1:1 images of marks at print resolutions of much greater than 400dpi, hence a degradation in quality occurs when images of marks are printed out. It would seem prudent to ensure future-proofing of fingerprint technology that 1000ppi is considered the industry standard. In addition, with the development of the Interpol I247 gateway to enable the digital transmission of fingerprints from European wide fingerprint bureaux and laboratories directly into Interpol AFIS systems, it will be incumbent upon technology providers to ensure that digital images of fingerprints are able to comply with not just industry standards around quality, but also with imaging formats such as 'NIST images' that are readily acceptable to multi agency AFIS infrastructures.

Following on from the recommendations from the McKie inquiry, as well as those from the Forensic Science Regulator, fingerprint bureau practitioners who provide analytical evidence will have to work

1 In December 2014, the UK connected to the Schengen Information System (SIS II) allowing forces to share information on persons, property (including documents) and vehicles of interest with other European countries under specific circumstances.

to more exacting standards and be able to demonstrate reliable and well-documented findings and conclusions. This requirement will demand a paperless technology that can both support and enhance current best practices around verification, contemporaneous note taking and evidential presentation of reports. This may include future challenges to develop appropriate triage tools to support focussed analysis of fingerprint material. Inevitably this may also include a requirement to further consider more accurate AFIS algorithms that are designed for 'lights out' processing of some crime scene fingermarks against custody databases. In addition, the way conclusions are arrived at and presented in a court room may involve more probabilistic results analysis utilising statistical models to support the evidence presented. This would bring fingerprint analysis more in line with other mainstream forensic techniques used in the criminal justice system at this time. One of the challenges from practitioners to adopting such probabilistic techniques is the perceived absence of robustness around current statistical models that fail to cater for the level of detail considered as part of the ACE-V process, namely 3rd level information. There is also more than one tool being developed for probabilistic analysis, which may use different algorithms and output different Likelihood ratios, all of which will need explanation to the court before they can become widely accepted. As such, there will be a continued need to develop best practice around statistical modelling through a collaborative approach between technology partners, academic stakeholders, and practitioners.

Finally, technology must consider the destination of the evidential journey; the courtroom. There has historically been a lack of a joined-up approach to how technology can link crime scenes, fingerprint bureau examiners, and the CPS and courts in order to best serve justice and speed up the legal process. Mechanisms to enhance the presentation of fingerprint evidence in court, as well as to demonstrate a link to other evidence types, using digital display and 3D representation that links into the CSI interpretation of crime scenes, will give courts a better understanding of the scientific evidence and aid the understanding of juries and legal professionals. Too often, resources are wasted by the compulsory attendance at court of expensive forensic personnel and experts. Technology should be able to support the need to provide secure remote testimony allowing, in theory, practitioners to present evidence from another location, avoiding the costly requirement to spend hours or even days waiting in court witness rooms. However, it is accepted that this may require a wider philosophical and practical discussion between key stakeholders to assess the viability of such processes, even if the technology were possible.

3.3 The Wider Application of Fingerprinting in the UK

It is vital that a document intended to provide a snapshot of where fingerprint science and technology is evolving, should also consider the wider use of fingerprints in the modern world outside of the traditional policing environment. In addition, there needs to be an understanding of how the introduction of technology to support wider biometric applications can be introduced safely that both ensure enrolment reliability, but also safeguard privacy and data security to provide effective information governance once such systems are introduced. Finally, there needs to be a sensible debate about when it is appropriate to gather biometric data such as a fingerprint and to consider for what reason it is being used and to understand the impact on public confidence the use of such biometric material has on the public perception and confidence in human identification systems.

Fingerprint identification systems are broad and varied in how they are used and it is true to say that only a fraction of fingerprint identification technology is now routinely used in the Policing domain. For example, fingerprints can be used to prevent fraud in voting exercises. Many countries employ fingerprint registration systems to ensure against voter fraud. Fingerprints can also be used for employee access control as well as to monitor time and attendance. Within the office environment IT access authentication systems can also use fingerprints to facilitate the auditing of mouse click protection of sensitive data. Indeed, fingerprint biometrics can support a whole range of consumer applications, which aid the consumer at the point of sale.

In Policing, it is known that the life span of automated fingerprint matcher technology is nearing its end as the current contract expires. There is a provision for continuity of the operational life of the 'Ident 1' capability, known as the Forensics and Biometric Interim Capability Service (FABrIC). This interim

solution will be in place until the Home Office Biometrics Programme delivers a longer-term solution to replace both FABrIC and IABS; the immigration and asylum fingerprint system. There is still a clear vision for a move to more integrated biometrics platforms that link in case management systems with a wide and diverse set of biometric tools, of which fingerprints will be just one. Now, and in the near future the Home Office Biometric Programme will be seeking ways to develop both current and future biometric platforms to consider how to serve the needs to ensure border protection, immigration monitoring, the exchange of international intelligence as well as to support a pan-European fingerprint exchange to fight organised criminality.

The challenge for new stakeholders and developers willing to access this challenging arena is to seek ways to improve and facilitate new information accessibility and sharing facilities, in order to support cross agency cooperation, both domestically and across borders. Considerable on-going research is required to support development of such multi-modal biometric systems which should begin to consider the way that traditional policing infrastructures can be safely linked to wider private biometric applications that facilitate a still wider capability to share valuable information and intelligence.

Of paramount importance as fingerprint technology plays an increasingly important roles in the wider marketplace, which can include fingerprint applications on smartphones, gaming consoles and other networking solutions and mobile communications devices, is the security of the data held to safeguard against identity theft and other risks to public confidence in such systems. The fact that technology can track the actions of people like never before means that the role of such people as the Biometrics Commissioner is vital in protecting the interests of the public to use legislative powers and other consultation to protect the rights of the individual. The issues of the day, and which both developers and end users must consider, is what is ‘reasonable’ to ask for by way of biometric solutions and whether the introduction of systems are rational, proportionate and effective in providing reassurance as to the security of data. Accessibility by those who may want to gain access to such data maliciously needs to be safeguarded. As more and more fingerprint solutions become an everyday part of life (the school child using a fingerprint access verifier to buy a school dinner), the boundaries that define ‘reasonable’ and ‘proportionate’ will become more blurred. Developers and users alike will have to be guided by legislators and regulators as to what is acceptable as a viable fingerprint solution against one that will ultimately create legal as well as ethical challenges. Such challenges will ultimately guide and shape stakeholder interest in pursuing such biometric solutions and shape how academia, developers and end customers will want to take innovation to market.

Through knowledge transfer, it is hoped that closer partnerships between policing, academia and the private sector will result in cross-harmonisation of technology between these different fingerprinting domains, allowing a more joined up approach to the development of novel techniques.

Examples of some of these organisations and applications are provided below:

Disaster Victim Identification

Along with DNA, odontology and many other identifying features (tattoos, personal effects and clothing), fingerprints are used as a method of disaster victim identification. After the 2004 Tsunami in South East Asia that caused the death of many residents and tourists from across the world, police agencies joined an international effort to use automated fingerprint recognition systems to try to identify victims by comparing the fingerprints of the deceased with ante-mortem fingerprints from their property, house or identification documents. Biometric data was being used, probably for the first time on this scale, in a civil application to identify victims, rather than to apprehend offenders. It is clear that had many people not enrolled into biometric systems during their lives, then many of the victims of the tsunami may still remain unidentified. This is also true of victims of recent major airline disasters.

Disclosure and Barring Services

The UK Disclosure and Barring services carry out vetting checks on individuals where this is required, particularly during the application process for employment working with vulnerable adults or children. Disclosure and Barring services do not routinely request or take fingerprints from applicants, but, should there be questions relating to identity during the vetting process, can request that prints are taken by the

police according to the Police Act 1997, 118 part 5.

Ministry of Defence

The Ministry of Defence (MoD) utilises fingerprints and has the facilities to collect and process fingerprints internally.

For example, Defence specialist Steria partnered with Human Recognition Systems (HRS) to win the MoD contract to deliver a ground-breaking Biometric Data Capture System (BDCS). The BDCS project combined identity checking, biometric site access control and mobile biometric capabilities with HRS responsible for working with global biometric partners, L1, to integrate a number of additional key functions within the mobile platform.

The system identifies individuals as they enter UK Controlled Bases and provides confirmation of identity via multi-modal biometric enrolment and search capabilities. Individuals enrol irises, 10 fingerprints, facial image and biographic data. Viewed by the MoD as essential to help secure and control access to military facilities in the field, BDCS is currently operational across a number of military sites and provides an integral mobile biometric capability that can be scaled to meet requirements.

Border Forces

UK Border Force has facilities to collect and process fingerprints. For example, in November 2008, the UK Border Agency introduced Biometric Residence Permits. These applied to foreign nationals of countries outside the European Union who were granted leave to remain in the UK.

Under these regulations, people over the age of six are required to provide 10 fingerprints plus a digital photograph – similar to the regulations in other countries across Europe.

Department for Work and Pensions

The Department for Work and Pensions do not directly take or process fingerprints, but if they have criminal intelligence then they will pass this on to the police who will conduct an investigation, which may involve the use of fingerprints.

Biometrics in UK Schools

In May 2012, the BBC reported that approximately 33% of secondary schools in the UK were requiring parents to identify themselves with biometric identification systems. The Independent newspaper has recently reported that over a million secondary school pupils are being fingerprinted, with four out of ten schools now using biometric technology for the identification of personnel. According to Sion Humphreys, policy adviser to the National Association of Head Teachers, “Schools can find this technology extremely useful to help efficiently administer systems like cashless catering and borrowing library books. As a result, the use of biometrics is likely to become more widespread.” Currently the most popular system is that of fingerprint recognition, and this is being seen more regularly across the UK and Europe. The use of such technology and processes in schools is also considered subject to the Protection of Freedoms act.

The Post Office

Foreign Nationals Biometric Residence Permits: the Post Office has the facility to collect fingerprints from foreign nationals wishing to apply for a resident’s permit. Foreign nationals who have been sent a bar-coded biometric notification letter from the Home Office can go to one of 100 post office branches offering this service where their photograph will be taken and their fingerprints and signature captured and sent securely to the Home Office.

Visa Fingerprints

Many UK fingerprint bureaux provide a Visa Fingerprint Service. This service is responsible for the collection of fingerprints of members of the public who are currently residing in the UK and require Police Clearance certificates from abroad to travel or to emigrate.

National Crime Agency Missing Persons Bureau

The National Crime Agency (NCA) Missing Persons Bureau holds the fingerprints of persons reported missing within the UK. The bureau compares these prints against those taken from unidentified human remains.

Biometric Password Protection

Technology now exists that includes the facilities to utilise fingerprints as a biometric password to restrict access to a device. This has made the security application of fingerprints a routine occurrence for many consumers.

Public & Private Sectors

In the UK, Biometric identification systems are commonly used for a number of other purposes, including (but not limited to):

- Payment processing
- Customer loyalty schemes
- Automated cash dispensers
- Access to secured areas
- Passports
- Work permits
- Healthcare
- Gyms and leisure centres
- Driving licensing
- Voting
- Welfare

The acceptance of biometric technology as a viable method is definitely a slow-burner, but it is taking hold in the UK and across the rest of Europe. The pursuit of ultimate convenience in everyday life, combined with the very real threat of crime and identity theft, means that various sectors are embracing biometrics.

It is important to remember the above exceptions to the standard fingerprinting process may also feed into the Criminal Justice System and that the system may deal with fingerprint evidence that has not come directly through the UK policing route. It is crucial, however, to maintain the boundaries between civil and criminal uses of fingerprints in order to protect civil liberties and maintain public confidence.

As it is the remit of the Forensic Science Special Interest Group to encourage innovation, it is important to highlight the potential for innovation opportunities through the transfer of knowledge between the core fingerprinting process and other organisations carrying out fingerprinting within the UK. Whilst these opportunities are not further discussed within this report, this is acknowledged as an important area for future work.

4. Key Stakeholders

For the purposes of this document the key stakeholders that take part in or influence the progression of fingerprint evidence throughout the criminal justice system have been grouped into the following categories: policing; training, regulation, accreditation; industry; and research and development.

- Policing stakeholders relate to those directly involved in the location, recovery and development or analysis and comparison of fingermarks.
- Training stakeholders relates to stakeholders involved in training, regulating or accrediting fingerprinting procedures.
- Industry stakeholders will include those who manufacture technology for use within the fingerprint domain; those who supply equipment and systems to fingerprinting clients; and forensic providers who offer fingerprinting services to police force based and independent customers.
- Research and development stakeholders relate to those who are either actively engaged in research in fingerprint technology or processes or those who educate and teach the subject matter.

The stakeholders detailed under each category are summarised in Table 1.

Table 1 – Categorisation of key stakeholders

Stakeholders according to Category	Subgroups within this category
Policing stakeholders (Section 4.1)	***National/regional bodies*** – including ACPO, SPA, PSNI/FSNI, Police and Crime Commissioners, National Fingerprint Office, Home Office Ident 1, Home Office Biometrics Programme
	Police stakeholders –including individual roles within the police structure such as SOCOs, Laboratory officers, imaging specialists, fingerprint examiners, scientific support managers, intelligence officers, investigating officers
	Judiciary stakeholders – including CPS, defence lawyers/experts
Training, regulation and accreditation stakeholders (Section 4.2)	***Training bodies*** – including College of Policing, Metropolitan Police Academy, SPA Training college, Police force forensic trainers
	Regulation and accreditation stakeholders – including Forensic Science Regulator, Home Office, UKAS, Biometrics Commissioner
	Providers of guidance – Home Office CAST
	Professional bodies – including the Chartered Society of Forensic Sciences, Fingerprint Society, Skills for Justice, European Division of IAI
Industry stakeholders (Section 4.3)	***Enhancement chemical and equipment suppliers*** – including ARRO SupraNano Ltd, Consolite Forensics, CSI Equipment Ltd, Forensic Source, Foster and Freeman, Global Forensics, Intelligent Fingerprinting, TetraSoc, WA Products, Weiss Gallenkamp, West Technology
	Imaging equipment suppliers – including AGX, Foster and Freeman, Iceni Forensic Ltd
	Identification technology and case management system suppliers – including Locard Case Management system, Northgate Socrates, Pattern Analytics
	Specialist fingerprint consultancy – including Forensic Focus, Principal Forensic Services
Research and Development stakeholders (Section 4.4) – also see Appendix 5	***Academic R&D*** – including University of Abertay, Dundee University, University of Huddersfield, Kings College London, University of Leicester, Sheffield Hallam University, Staffordshire University, University of Strathclyde, University of Teesside, University College London
	Government R & D – including Home Office CAST, Dstl
	Industry R & D – including Cognitive Consultants International, Foster Foster and Freeman, West Technology

Key stakeholders within each category are described, defined and discussed within the sections signposted in Table 1, although the included stakeholders should by no means be seen as exhaustive.

4.1 Policing Stakeholders and their principal functions

Policing stakeholders can be categorised as those involved in the operational development, analysis, and comparison of fingermarks, as well as those with a wider policing and investigative influence on this core process.

4.1.1 National and Regional Bodies, and the Judiciary

ACPO Lead for Forensic Science

An ACPO (Association of Chief Police Officers) Officer is appointed as the National Policing Lead for Forensic Science, part of the ACPO Crime portfolio. This role is currently performed by the Chief Constable of West Midlands Police. The Forensic Science portfolio is subdivided into committees that focus on particular aspects of forensic science in general (such as Training and Standards) and some on fingerprints in particular. Such committees may be chaired by senior police officers or by civilian police staff such as scientific support managers. Within the current structure sub-committees of relevance to fingerprints exist covering Fingermark Enhancement Laboratories and Crime Scene Examination. Both of these are run by scientific support managers.

ACPO Lead for Forensic Databases and Fingerprints

An ACPO Officer is appointed as the National Policing Lead for Forensic Databases and Fingerprints. This role is currently performed by the Chief Constable of West Mercia Police. The principal concern of this group is the administration of the principal identification databases operated within the UK, namely Ident 1 (the fingerprint database, containing 7.1 million 10 print sets), and the National DNA database (NDNAD).

Scottish Police Authority (SPA)

Forensic science provision in Scotland now comes under the remit of the Scottish Police Authority (SPA), providing a comprehensive crime scene to court service, including fingerprints as one of many disciplines under the remit of one organisation. In the past, forensic services in Scotland were provided by Scottish Police Services Authority (SPSA) but SPA now provides a complete and continuous service, bringing the various forensic laboratories closer together under one organisation in a more centralised geographical location.

Northern Ireland (PSNI and FSNI)

Forensic science provision in Northern Ireland is partly conducted by the Police Service of Northern Ireland (PSNI), which has a fingerprint enhancement laboratory and fingerprint bureau. PSNI work with the Forensic Science Service of Northern Ireland (FSNI), which has facilities equipped to conduct joint forensic examinations for fingerprints and DNA, and also deals with the forensic aspects of most of the serious crimes investigated within Northern Ireland.

Criminal Justice System

Criminal justice is the over-arching system of practices and institutions of governments directed at upholding social control, deterring and mitigating crime, or sanctioning those who violate laws with criminal penalties and rehabilitation efforts. Those accused of crime have protections against abuse of investigatory and prosecution powers.

The CJS is the end user of fingerprint evidence. In the CJS the outputs of fingermark recovery and comparison are used in the courtroom to assist juries and the judiciary in decision making regarding guilt or innocence of the accused. Within the CJS, judges and prosecution and defence lawyers may require an understanding of fingerprint evidence, and/or rely on information provided by expert witnesses.

Crown Prosecution Service (CPS)

The Crown Prosecution Service is responsible for prosecuting criminal cases investigated by the police in England and Wales.

4.1.2 Police Forensic Stakeholders

Scenes of Crime Officers

Scenes of Crime Officers (SOCOs) (also known as Crime Scene Investigators (CSIs), Crime Scene Examiners (CSEs) and Scientific Support Officers (SSOs), depending upon the organisation in question) attend crime scenes to record and package forensic evidence, including fingermarks. In some police forces, Volume Crime Scene Examiners (VCSEs) are also employed, who are responsible for attending scenes of volume crime (such as thefts and burglaries), allowing the remaining SOCOs to focus on more major crime scenes. SOCOs often use physical techniques such as powdering to develop latent fingermarks at crime scenes and will then submit fingerprint lifts manually to the **Fingerprint Bureau**, or electronically via remote transmission devices from the SOCO bases. If items of evidence are present at the scene that are not suitable for powdering in situ then these items are collected by the SOCO, packaged to preserve the surface for future fingermark examination, and submitted to the **Fingerprint Enhancement Laboratory**. SOCOs are usually the first step in the process of the recovery of fingerprint evidence. SOCOs are increasingly being asked to develop more marks at the crime scene, scanning lifts or photographing marks in situ and transmitting the images back to the Fingerprint Bureau using remote transmission devises.

Fingerprint Enhancement Laboratories

Fingerprint enhancement laboratories (sometimes known as Fingerprint Development Laboratories) are responsible for the visualisation of latent fingermarks on items of evidence that have been recovered from scenes of crime (See **Scene of Crime Officer**), providing an in-house fingerprint recovery service to support operational policing. The laboratory must determine the most appropriate technique or series of techniques to visualise and enhance the fingermark according to the type and condition of the surface in question. The Centre for Applied Science and Technology (CAST) Fingermark Visualisation Manual (see Regulatory stakeholders in section 4.2) advises on best practice techniques and processes for the recovery of latent fingermarks. Often, the process of fingerprint recovery will begin with the use of a number of forensic light sources to attempt to visualise ridge detail present before chemical processes are used to develop the fingermark. Visualised or developed fingermarks are then captured, either photographically or using a specialist method of image capture (see **Photographic Services**). Images of the developed fingermarks are submitted physically by a **Scientific Support Courier** or electronically via a number of systems including remote transmission technology to individual **Fingerprint Examiners** or to the **Fingerprint Bureau** generically.

Each UK police force has traditionally run its own in-force laboratory but it is increasingly common for forces to share laboratory facilities as a predictive cost saving measure. Police forces may share laboratory facilities between forces, or they may make use of shared laboratory facilities with industry, local government, or academia. **Case Study 1** provides an example of the collaborative partnership between Hampshire Police and Portsmouth University.

CASE STUDY 1

Sharing Academic and Fingerprint Laboratory Resources: Portsmouth University and Hampshire Police

Hampshire Police is an example of a police force fingerprint laboratory that now shares resources with both the local government and academia. The fingerprint laboratory shares a facility with Hampshire County Councils Scientific Services and occupies its own laboratory areas within this building; operating in isolation from Scientific Services. However, as a result of the shared site, Scientific Services have now taken on some analytical work for Hampshire Police which has reduced the cost associated with the extensive outsourcing of this work for the fingerprint laboratory, and has ensured continued work for Scientific Services.

Portsmouth University Institute of Criminal Justice Studies (ICJS) and Hampshire Police Scientific Support have entered into a partnership that is focussed upon sharing resources and transferring knowledge. The partnership began informally approximately four years ago. Dr Paul Smith, Senior University Tutor at the ICJS, originally approached Hampshire police as part of some research that the university was carrying out into the use of the GL scanner (used to provide a scanned image of fingermarks lifted with a gel lifter), and through a business process review that Portsmouth University undertook on behalf of Hampshire Police Fingerprint Enhancement Laboratory. The fingerprint laboratory was keen to work with Portsmouth University as it had a need for research but lacked the resources to carry this out internally. Thus, an informal partnership commenced in which students carried out an internship within the fingerprint laboratory on an ad hoc basis during their undergraduate degree at the ICJS, the intention being that students mentored by Hampshire police would then carry out research projects to their benefit. Students would opt into this process, as it was not included as a requirement of their course, and would receive a mentoring and training programme at the laboratory. Portsmouth University have made a substantial investment in the partnership, investing in both a wet and dry lab at the university site along with rehousing the vacuum metal deposition machine (used for fingermark development) belonging to Hampshire Police that could no longer be housed within the fingerprint laboratory.

The university has now set up a working group to coordinate the mentoring program and is moving to formalise the relationship through the acquisition of a new facility to be shared by the ICJS and Hampshire Police. A number of the benefits of this partnership are described in Table 2 as are the challenges to date, in **Table 3**.

Table 2– Advantages of Portsmouth University and Hampshire Police collaboration.

Portsmouth University ICJS	Students at Portsmouth ICJS	Hampshire Police Fingerprint Laboratory
• The university has gained a unique selling point; the opportunity for students to take part in this internship programme and gain real life practical experience within a forensic setting. Such experience that is not commonly possible outside of employment or during other degree courses. • The university may gain publications as a result of student projects that are relevant real world research. • The university has gained guest lecturers from the fingerprint department who discuss the work of the laboratory as well as promoting the internship opportunity. • The university has built a solid working relationship with the police that can be developed in the future and may lead to further research and innovation partnerships.	• Students gain real world experience and carry out all aspects of the fingerprint laboratory job role. They do not just work on the glamorous or more interesting exhibits and processes, but also carry out routine admin and cleaning tasks that are part of the real world job role. • Students gain transferable skills from the workplace applicable to future employment, such as punctuality, a good work ethic, and team working. • Students are able to gain experience of dealing with real casework and experience first-hand the importance of maintaining the continuity and integrity of this evidence. • Students have the opportunity to promote themselves as reliable and skilful fingerprint technicians, potentially leading to employment within the force. Students can be considered 'job ready' after completing their degrees (although internship is not a substitute for full in-house or external official training such as that offered by the College of Policing). Two students from the first year of internships have achieved employment within the police force upon completion of their degrees. • Students are able to carry out undergraduate research projects that seek to solve real world problems, leading to research, which is likely to be highly publishable and relevant. • Students are able to take advantage of the expertise of the fingerprint technicians whilst carrying out their research and are able to use a combination of the university's laboratory facilities (a small scale replica of the police facilities) or facilities owned by the police (such as a Vacuum Metal Deposition chamber).	• The police have gained additional human resources who, after some initial training, are able to carry out certain tasks unsupervised freeing up the time of the practitioners for more complex tasks. • The police have gained the opportunity to commission bespoke research that could be of direct benefit to their operational output. • Practitioners have gained a sense of job satisfaction through the mentoring and supervision of students. • The police have gained access to equipment purchased by the university that could not be procured by the police force due to budgetary limitations. • The police have gained a storage facility for their Vacuum Metal Deposition chamber, which requires specialist housing and could not be transported to the new facility shared with Hampshire Council Scientific Services. • Through mentoring students at the laboratory practitioners will gain associate lectureships at Portsmouth University, meaning that they can access the academic resources available through the university.

Table 3 – Challenges of Portsmouth University and Hampshire Police collaboration.

From the perspective of Portsmouth University ICJS	From the perspective of Hampshire Police Fingerprint Laboratory
• This partnership has required the university to invest in equipment and facilities. Whilst students are able to use police equipment for the purposes of their internships, it is necessary that the students are able to use non-operational equipment for research due to strict calibration requirements of ISO 17025 and the need for operational equipment to be in constant operational use. • There has been some red tape that has needed to be broken through. Students need to be security cleared prior to the internship and there are legal issues surrounding formalising the partnership. • If students do not perform to a high standard or lack enthusiasm for the project then this can have a negative impact on the reputation of the university and the success of the partnership. This will be addressed in the future by a more comprehensive selection process for interns to ensure enthusiasm and competence.	• There are a number of issues surrounding security clearances, confidentiality, and health and safety that need to be addressed. Equally there are issues of quality that need to be considered, due to the quality standards and calibration required as a result of ISO17025 accreditation. • The potential risk of error occurring as a result of work carried out by a student intern. This is managed by strict quality assurance of all work carried out by mentees. • The time consuming nature of training an intern, meaning a reduction in the achievable workload of a practitioner during the time of this supervision. • Frustrations associated with training a student who will not necessarily be a long-term employee of the laboratory. • Issues with the quality of the work of individual interns and those with insufficient levels of skill/commitment. • Practical problems associated with the relocation of police equipment to the university campus. There are issues associated with transporting exhibits onto the university campus for treatment with VMD (now housed at the university), and the safe and secure transfer of firearms onto the campus for research and analysis is a current issue.

The success story of this academic – practitioner partnership demonstrates the potential to overcome the challenges, inherent in partnerships of this kind, to successfully share expertise, knowledge, facilities and equipment. In times of financial uncertainty, it would seem that this is a practical and sensible approach benefiting both sides of the partnership. Whilst there may be certain practical and logistical barriers to similar collaborations between other police forces and universities, it would seem that this is a good model for other stakeholders to investigate further.

Fingermark Development Practitioners

Fingermark Development Practitioners (also known as Laboratory Practitioners or Fingerprint Enhancement Practitioners) work within **Fingerprint Enhancement Laboratories**. Practitioners work to visualise fingermarks on items of evidence that have been recovered from crime scenes by **Scene of Crime Officers**. They select and carry out the most appropriate fingermark development technique, or sequence of techniques, according to the substrate of the item and the conditions it was found in (for example, whether it has been wet or dry), examine the item for developed (visible) fingermarks, and determine whether each fingermark is of sufficient quality to be submitted to the Fingerprint Bureau to be compared with fingerprints of persons of interest in the case. Fingermark Development Practitioners may also attend crime scenes to apply certain chemical treatments to fixed surfaces that cannot be removed from the crime scene and are not suitable for treatment using the range of processes available to the Scene of Crime Officers.

A summary of some common fingerprint development techniques is provided in **Appendix 1**.

Photographic Services

Police Forces often have their own in-house photographic services or imaging department. This department will often deal with all image capture of developed fingermarks and the production of hard copy or electronic images of these fingermarks for submission to the **Fingerprint Bureau**. Some **Fingerprint Enhancement Laboratories** will carry out their own photography or other imaging processes and **Scenes of Crime Officers** will also photograph fingermarks developed in-situ at the crime scene.

Scientific Support Couriers

Scientific Support Couriers are often used to securely transport physical items of evidence between departments within scientific support where these departments are not located on the same site. Often, electronic barcoding systems will be used to ensure that submission and receipt of items is recorded on evidence management systems to ensure continuity and the maintenance of a chain of custody. In relation to fingerprint evidence, a courier may transport items of crime scene evidence to a **Fingerprint Enhancement Laboratory** and may transport developed fingermark lifts or images from the laboratory to the **Fingerprint Bureau**.

Fingerprint Bureau

The Fingerprint Bureau is typically an in-house service within each UK Police Force, although, like Fingerprint Laboratories, some forces are also beginning to share this resource. Within the bureau the force's collection of ten-print fingerprint sets will be stored, either electronically or in paper form. The bureau is the workplace of **Fingerprint Examiners** and other members of police staff who have a role in the process of the comparison of a crime scene fingermark with the fingerprints of persons of interest associated with an investigation, or to sets of elimination fingerprints supplied by consent, which may include victims of crime and associated friends, family members or colleagues.

Fingerprint Examiners

Fingerprint Examiners are also known as Fingerprint Experts (though it is for the courts to decide whether the examiner has the skills and qualifications to be accepted as an expert in the eyes of the judiciary) and Latent Print Examiners. The role of a Fingerprint Examiner is to analyse a fingermark that has been recovered from a crime scene, observing and documenting the details present within the mark so as to establish whether it contains sufficient detail to be compared to an exemplar fingerprint (often that belonging to a suspect in the case or someone who has come to light as a result of a match against an automated fingerprint identification system (AFIS) or to eliminate individuals from the case). In the UK, the AFIS system currently in operation is called Ident 1. If sufficient detail is present then the examiner will carry out the comparison of the mark with an exemplar print. The exemplar print may have been provided to the fingerprint bureau through intelligence in the case, or returned by an AFIS search for similar fingermarks contained within the database. It should be noted that a victim or member of the public could also donate an exemplar print in order to eliminate them from investigation etc. If an examiner is able to make an identification between a crime scene fingermark and an exemplar fingerprint, then this fingermark is passed to an additional fingerprint examiner to verify the conclusion. While many UK bureaux currently require a total of three checks against every identification (the original checker and two further checkers), some bureaux are now considering reducing this requirement to only one verification (total of two checks only). There is no legislative or scientific reason for the three-check process and this is a historic process that is seen by some as increasingly redundant in the modern bureau environment. The outcome of a fingerprint comparison can either be an identification, an elimination, or the comparison could be inconclusive. Fingerprint examiners follow the ACE-V process as summarised in **Appendix 2**.

Ten print Officers

Historically, UK **Fingerprint Bureaux** carried out comparisons using paper based ten-print cards taken from persons in connection with criminal cases. It was the job of a ten-print officer to be responsible for the filing of ten-print cards after having used Ident 1 to provide proof of identity checks against existing ten-prints held on file, so that records held on the Police National Computer (PNC) might be accurately

maintained and updated. Most UK Police Forces are in the process of digitising their ten-print fingerprint records and are also moving toward what is known as 'lights out processing' whereby most ten-print card checks will become an automated process. This will reduce staffing and storage requirements meaning that these Fingerprint Bureaux will, essentially, be able to move toward a paperless facility; fully computerised and with smaller number of comparison centres.

Fingerprint Bureau Manager

A Fingerprint Bureau Manager will often have responsibility for the overall running of the fingerprint bureau, although, in some cases, this responsibility may fall directly to the **Scientific Support Manager**.

Fingerprint Trainers

Fingerprint Bureaux often have an in-house training officer to assist in the delivery of the National Fingerprint Learning Programme for Fingerprint Examiners run by the College of Policing, or to deliver a comparable training programme in-force. The trainer will also be responsible for ensuring the Continual Professional Development (CPD) and Continual Professional Competency (CPC) of Fingerprint Examiners within the Bureau.

Scientific Support Managers

Typically UK Police Forces employ a Scientific Support Manager (SSM) who has responsibility for the provision of forensic evidence to an operational policing customer, be this through in-house analysis or the procurement of external forensic services. The Scientific Support Manager is often ultimately responsible for the Force's **Scenes of Crime Officers** and Volume Crime Scene Examiners, **Fingerprint Development Laboratory** and **Fingerprint Bureau**. The requirements of different Forces vary with respect to the qualifications and background of their Scientific Support Managers. Some forces employ police staff with scientific backgrounds, whilst others employ senior ranking police officers to the role. As a number of UK Police Forces have begun to merge their Scientific Support Services the number of Scientific Support Managers has decreased. This has led to the creation of a number of similar roles, including Heads of Scientific Support responsible for a number of Police Force Scientific Support Departments.

4.1.3 Police Non Forensic Stakeholders

Senior Investigating Officers (SIO)

The Senior Investigating Officer (SIO) is the police officer (typically the rank of Detective Inspector or above) responsible for leading a criminal case. In serious cases, the SIO may deal directly with the **Fingerprint Enhancement Laboratory** and **Fingerprint Bureau** to request results and updates in relation to the progress of the fingerprint evidence, particularly if the case is time-pressured or sensitive. The SIO may provide intelligence to the Laboratory in order to prioritise evidence recovery in areas of high importance, although should control the information provided in order to mitigate the potential for cognitive bias (see section 6.3).

Exhibits Officer

An exhibits officer is the police officer within the investigative team who has been assigned responsibility for the organisation, continuity and integrity of all exhibits in relation to the case.

Intelligence

Intelligence in relation to a criminal case is information that could be used to direct or progress an inquiry. Intelligence may be passed to a **Fingerprint Enhancement Laboratory** to inform a targeted search for fingermark evidence or to direct resources to certain areas, prioritising items of evidence in a case. Intelligence may also be passed to a **Fingerprint Bureau** in the form of communicating suspects in the case for comparison purposes, or sets of fingerprints for elimination. Equally, intelligence can be passed from the Laboratory or the Bureau to the **Senior Investigating Officer** in the case, for example, fingerprint identifications and locations.

4.2 Training, Regulation and Accreditation Stakeholders

The 'training, regulation, and accreditation' stakeholder category contains stakeholders involved in the training for, regulating, or accrediting of fingerprinting procedures. This category includes stakeholders and organisations with regulatory powers as well as those who take on more of an informal regulation role. Stakeholders are listed alphabetically with a description of their role in, or influence on, the fingerprinting process. This section also provides a number of case studies with additional information about particular aspects of training, regulation and accreditation with UK fingerprinting.

4.2.1 Training Stakeholders

The College of Policing (CoP)

The Forensic Centre of the College of Policing has developed a number of specialist courses within the fingerprint domain, which it delivers to national and international Police Forces and other providers of fingerprint evidence. The Forensic Centre is based at Harperley Hall in Durham and provides a state of the art training facility. The Centre works with the Forensic Science Regulator, Skills for Justice and higher educational establishments to ensure the quality and functionality of the training provided. Training programmes are designed to meet operational needs and more recently have also gained accreditation as well as foundation degree status from academic bodies including Teesside University. Further information on the training provided by the College of Policing is included in **Appendix 3**.

Police Force Forensic Trainers

Not all UK Police Forces procure training for their specialist forensic staff through the College of Policing, some chose to provide training in-house through designated forensic trainers. These trainers may be practitioners themselves or may be employed solely to deliver this specialist training. The Metropolitan Police Service is an example of a Police Force that provides all forensic training internally including running a Crime Scene Examiners (CSE) training course at its own Police Academy, and providing training and assessment for Fingerprint Examiners and Laboratory Practitioners. Successful completion of these courses results in the award of a foundation degree from Teesside University. Police Forces, which do outsource initial training to the College of Policing, will still require internal stakeholders responsible for on-going training and development, including the formal post-requisites of the College of Policing courses.

4.2.2 Regulatory Stakeholders

The Forensic Science Regulator (FSR)

The role of the Forensic Science Regulator is to set, maintain and monitor forensic science quality standards within the UK and to ensure that forensic science, carried out across the CJS, upholds these standards. Currently, compliance with the Regulator's Codes of Practice and Conduct for Forensic Service Providers and Practitioners in the CJS is voluntary, but statutory powers for the Regulator to enforce scientific quality standards within forensic science are currently out for consultation. The Fingerprint Quality Standards Specialist Group advises the Forensic Science Regulator in the area of fingerprint quality standards. The work of this group is discussed further in Section 5.1.2.

Home Office Centre for Applied Science and Technology (CAST)

Although not a regulatory body, the Home Office Centre for Applied Science and Technology (CAST) produces documents that are used as fundamental guidance for those working in fingermark enhancement and imaging. CAST is a part of the core Home Office that provides scientific support and advice to both operational and policy units. Its precursor organisation, the Police Scientific Development Branch, was established in the late 1960s to support the various aspects of the operational work of the police with solutions obtained through scientific research and development. Fingermark enhancement and fingerprint identification are both scientific functions that have traditionally been carried out internally by police forces as opposed to being outsourced to external forensic service providers (as is the case for

DNA analysis). As a consequence, CAST have been actively involved in supporting the work of police Fingermark Enhancement Laboratories and Fingerprint Bureaux for over 40 years.

This support is provided in several ways:

- Provision of advice on particular casework scenarios requiring fingermark enhancement;
- Loan or provision of access to specialist equipment and facilities not available to every Police Force;
- Research and evaluation of novel processes with potential to give operational benefits over existing practices;
- Validation of processes to minimise the resource burden on police force laboratories seeking ISO 17025 accreditation; and
- Publication and maintenance of the Fingermark Visualisation Manual.

The principal output of CAST's work is the Fingermark Visualisation Manual, which has recently been comprehensively revised and was published in January 2014. The Fingermark Visualisation Manual is used in the fingermark enhancement laboratories of all UK Police Forces and other law enforcement agencies. Its principal purpose is to provide guidance to maximise the recovery of fingermarks and other forensic evidence as part of the investigative process, and to enable this to be conducted both safely and effectively. Details of the contents of the Fingermark Visualisation Manual are provided in **Appendix 4**.

CAST also produce the Fingerprint Source Book, which is a collection of evidence generated by CAST over a number of years to support CAST recommendations for fingermark development techniques within the Fingermark Visualisation Manual. This information was originally intended for a CAST internal audience, with the intention being that this supporting evidence could be used to assist in the process of gaining UKAS accreditation for the fingermark development processes included within the manual. The source book (CAST 2013) was released into the public domain as it was recognised that it may be a valuable document to assist Police Forces wishing to carry out their own in-house validation process, and in the interests of transparency within the fingerprint domain. The document was made public in June 2012 and is signposted as a point of reference in the new version of the Fingermark Visualisation Manual published in January 2014. Validation reports that have links to the Source Book and related academic journal articles are available (to those who have access) via the Police Online Knowledge Area (POLKA) (further described in Section 5.1.2). It should be noted that the CAST Fingerprint Source Book is a different publication to the National Institute of Justice (NIJ) Fingerprint Source Book, published in the US, which was always intended for the public domain.

4.2.3 Professional Bodies

The European Division of the International Association of Identification (IAI)

The European Division of the IAI was founded in August 2014. The body is targeting a varied membership from a range of disciplines, including student members, industry stakeholders and academia. The Euro IAI will hold annual research and development conferences as well as individual learning seminars and subject matter workshops at which academic and industry based research is presented. The current (2014) Board of Directors includes Dr Aldo Mattei as President, Dr David Charlton as Secretary to Board of Directors, and Dr Marcel de Puit.

The Chartered Society of Forensic Sciences (CSFS) (previously the Forensic Science Society)

The Forensic Science Society was founded in 1959 and is the professional body of the forensic science community, with a varied membership from a range of disciplines, including student members, members and fellows. There are approximately 2800 members across all membership categories. The society holds a biennial research and development conference at which academic and industry based research is presented. The society publishes a peer reviewed academic journal, Science and Justice. The current President of the society is Mr Tom Nelson. It became a Professional Body in 2004 and has recently been awarded a Royal Charter to enable the formation of a new body called The Chartered Society of Forensic Sciences (CSFS). As a consequence the Society can now offer 'Chartered' as well as 'Accredited' status to its membership.

The Fingerprint Society (FPS)

The Fingerprint Society was founded in 1974 as an organisation for fingerprint examiners. The society now has approximately 450 members from 30 countries around the world. The society holds an annual conference and produces Fingerprint Whorld, which is a quarterly peer reviewed journal. The aim of the Society is to 'advance the study and application of fingerprints and to facilitate the cooperation among persons interested in the field of personal identification'. As such, the society encourages a multidisciplinary membership and content to its journal.

4.2.4 Accreditation Stakeholders

The United Kingdom Accreditation Service (UKAS)

The United Kingdom Accreditation Service is responsible for providing accreditation to UK forensic science providers (including police force internal services). The accreditation required by providers of forensic science laboratory services and by providers of crime scene services is ISO17025 and ISO17020, respectively.

The International Organisation for Standardisation (ISO) is a global federation of national standards bodies that develops standards in response to sectors and stakeholders that express a clearly established need for them. These standards are developed by technical committees comprising of experts from the sectors that have asked for the standards to be generated. Adoption of the EU Framework Decision 2009/905/JHA has proven to be a driver for review and possible change of standards that may have been adopted by UK Police Forces. In particular, this is with regard to accreditation of forensic service providers carrying out laboratory activities.

The Forensic Science Regulator, in partnership with ACPO and key stakeholders, has reviewed the current situation and formulated a national response to the requirement for change, identifying the minimum requirement to be the implementation of ISO 17025 for fingerprint enhancement laboratories by November 2015.

The scope of BS EN ISO/IEC 17025:2005 is to demonstrate that laboratories operate a quality system, are technically competent, and are able to generate technically valid results. It also specifies the general requirements for the competence to carry out tests and/or the calibrations required, including sampling. In short it provides an internationally recognised accreditation that a laboratory is working to the highest of auditable standards. It is the intention that work conducted at the crime scene will become accredited to the ISO 17020 standard, and this will also be administered by UKAS.

Skills for Justice

Skills for Justice (S4J) is primarily responsible for delivering the National Occupational Standards (NOS) for forensic science. S4J also offers support to police forces in meeting ISO17025 requirements, for example by ensuring that there is sufficient benchmarking of standards around training provision in order to fulfil future quality assurance requirements. They work collaboratively with a number of organisations and working groups within forensic science provision, including the College of Policing Training Centre at Harperley Hall. They are currently undertaking a number of projects including the development of an electronic portfolio that will allow forensic practitioners to electronically log their own continuing professional development in conjunction with the CoP, and are also working with the CoP to deliver a workshop in relation to Professional Judgement within forensic science for Fingerprint Examiner and Laboratory Staff.

In addition in 2009, S4J carried out research into the quality of forensic science education within the UK. As a result of this research the UK Forensic Science Education Group (under the Chairmanship of Mr Brian Rankin) developed a QAA Subject Benchmark for Forensic Science, which was made available in 2012.

4.3 Industry Stakeholders

A sample of stakeholders from industry is described in this section. The stakeholders in this sample are divided into:

- Those who manufacture technology for use within the fingerprint domain;
- Those who supply equipment and systems to fingerprinting clients; and
- Forensic providers who offer fingerprinting services to police force based and independent customers.

It should be noted that this is not intended to be an exhaustive list of stakeholders, but, instead, provides a starting point for the benefit of external innovators and an example of the technology and services currently on offer within the domain. Inclusion in this list does not imply endorsement or recommendation by the authors of this report or by the Forensic Science Special Interest Group. Stakeholders under each category are listed in alphabetical order.

4.3.1 Technology Manufacturers

ARRO SupraNano Ltd

Manufacturer of a range of fingerprint powders. The design of these powders is based upon research that originated at the University of Sunderland and their production is now conducted from facilities at Newcastle University. These powders are marketed as providing greater definition and functionality than traditional fingerprint powders.

Consolite Forensics

Manufacturers and suppliers of two pieces of fingerprint equipment, the CERA LT, an automated system for imaging fingermarks on firearms cartridge cases, and the HPS (Hot Print System), which thermally develops fingermarks on thermal paper (e.g. point of sale receipts), developed in conjunction with Dr John Bond of Leicester University (Further details of this collaborative project are provided in **Case Study 3, Section 4.4**.).

Foster and Freeman

Major manufacturer and supplier of a range of fingerprint equipment, including imaging equipment, forensic light sources, cyanoacrylate chambers, the ‘one step’ superglue chemical Polycyano UV, TFD2 and ESDA (electro static detection apparatus). Foster and Freeman are a major exporter of this equipment, worldwide.

Global Forensics

The producer of AFIS+, an automated fingerprint identification system that incorporates a top scoring algorithm developed within the University of Warwick and tested by the US National Institute of Science and Technology (NIST). The system extracts the detail required from a fingermark negating the time usually spent preparing a fingermark for an AFIS search.

Global Forensics also market Lumicyano, A ‘one step’ superglue with fluorescent properties, negating the need for staining and drying an exhibit prior to examination.

Iceni Forensic Ltd

Iceni Forensic Ltd has produced the Iceni Scan Tablet kit. This is a scene-based device that enables Crime Scene Examiners to scan BVDA gel lifters at a crime scene. Gel lifters can be used to lift a print prior to the addition of fingerprint powder. The tablet consists of a portable vacuum stage and pump that holds the gel lift flat and in place, enabling it to be scanned on a conventional flat bed scanner. The scanner provides an image showing the contrast between any raised particle of fingermark deposit and the background surface. The image can then be remotely transmitted to the Fingerprint or Footwear Bureau.

Intelligent Fingerprinting

Intelligent Fingerprinting was founded in 2007 and is a spin out company from the University of East Anglia. They have developed a device that can provide point-of-care diagnostic screening of a fingerprint, analysing a number of metabolites within the fingerprint residue that can be used to determine what an individual has consumed or inhaled illicit drugs. In 2012 Intelligent Fingerprinting was successful in raising £2 million in funding from a consortium of private US companies along with UK government funding for pilot studies within the NHS and forensic domain.

Weiss Gallenkamp

Manufacturer and supplier of fingerprint development ovens to carry out treatment with Ninhydrin and DFO.

West Technology

Manufacturer and supplier of a range vacuum metal deposition equipment for fingermark enhancement, ranging from large fixed systems with external pumping systems to the recently introduced, self contained bench top system.

4.3.2 Equipment and Systems Suppliers

AGX

Producer of bespoke computer systems for UK policing and forensic science provision. AGX is currently working with Pattern Analytics to produce the FIBRE remote transmission software currently being developed in conjunction with Surrey and Sussex Police.

Crime Scene Investigation Equipment Limited

Crime Scene Investigation Equipment Limited manufacture and supply a wide range of equipment for crime scene investigation, including a range of fingerprinting equipment and chemicals.

Forensic Source

Provider of a range of forensic science and fingerprinting equipment.

Locard Case Management System

Developer of the case management software Locard, used by a number of UK Police Forces.

Northgate Socrates

Developer of the case management software Socrates, used by a number of UK Police Forces.

Pattern Analytics

A company initially formed as Warwick Warp from within Warwick University. Pattern Analytics has worked with AGX to produce FIBRE remote transmission software currently being trialled with Surrey and Sussex Police.

TetraSOC

Provider of a range of forensic science and fingerprinting equipment.

WA Products

Provider of a range of forensic science and fingerprinting equipment.

4.3.3 Forensic Providers (providing specialist fingerprinting services)

Forensic Focus

Forensic Focus Ltd is a consultancy company specialising in fingerprint services and quality management. Forensic Focus is run by experts in both fingermark development and fingerprint identification and provides a variety of services including proficiency testing, support for academic research, teaching and recruitment.

Principal Forensic Services

Principal Forensic Services (PFS) was set up after the closure of the Forensic Science Service. The members of Principal Forensic Services are experts in a variety of fields across the domain of forensic science. PFS offers specialist location and recovery of fingerprints and footwear marks and the development and analysis of fingermarks in blood.

4.4 Teaching, Research and Development Stakeholders, and Current Innovation

The teaching, research and development stakeholder category provides a brief introduction to taught forensic science academic courses and course accreditation, and details current research and development within the fingerprint domain. This research is not limited to academic stakeholders, but also encompasses research undertaken in industry and by practitioners. Methods of dissemination of research are then discussed and some case studies featuring current and recent innovation projects and collaborations are provided.

4.4.1 Academic Forensic Science in the UK

There is a considerable range of academic training and education available within the forensic science domain in the UK, with approximately one third of the UK Universities offer a forensics-related course. Many offer full time taught courses at undergraduate and/or postgraduate level. Many of these courses include taught elements that focus upon the development and comparison of fingerprints, which can include a diversity of subject matter including aspects of the chemistry of fingerprint secretions to the issues associated with the subjective interpretation of fingerprint evidence. In addition, many undergraduate and postgraduate researchers will undertake novel research projects within fingerprinting.

All Universities must meet the Quality Assessment Agency (QAA) benchmark if they offer full undergraduate and post graduate courses in forensic science. In addition, the benchmark requires fingerprinting to be incorporated. The forensic science foundation of the QAA benchmark was one of the component standards developed by the Chartered Society of Forensic Sciences (formerly the Forensic Science Society). The Chartered Society of Forensic Science accredits undergraduate and postgraduate taught courses at over 20 UK Universities. Courses are also accredited in Europe and Australia. The accreditation programme focuses on accrediting particular taught elements of the courses and assessed in three categories:

- Interpretation, Evaluation & Presentation of Evidence (core);
- Crime Scene Investigation; and
- Laboratory Analysis.

In addition, accreditation is offered in the following specialist areas:

- Computer Network Evidence Recovery and Analysis;
- Digital Evidence Analysis, Recovery and Preservation;
- Forensic Anthropology; and
- Forensic Archaeology.

If a particular course achieves accreditation in three areas including the core Interpretation, evaluation, and presentation of evidence strand, then this course is said to be an ‘accredited course’.

There is some debate about the desirable content and emphasis that forensic science degree courses

should have. There is an argument that a sound basis in a pure scientific subject (such as biology or chemistry) with a later specialism in a forensic field is a good route to achieve a combination of a strong scientific skills base and an ability to apply this successfully to a forensic application. Equally, there is an argument that forensic teaching should be directly relevant to the skill sets required in a forensic science vocation; a more practical course content that readies students for a career as a practitioner. Similarly, the ideal content of a forensic science degree is debatable; e.g. should it contain more practical and vocational content or should the emphasis be on interpreting evidence with a scientific method and providing an awareness of the issues that surround this? The QAA benchmark has addressed many of these issues. **Case Study 2** discusses the importance of accreditation in ensuring a balanced forensic science education.

CASE STUDY 2

The Benefits of Accreditation to Academic Courses

The establishment of the Chartered Society of Forensic Sciences Accreditation scheme was as the result of an explosion of courses in forensic science. Some of the available courses had debatable merit in terms of their academic quality, as well as content and suitability. The professional body accreditation scheme, together with the recently created Higher Education QAA benchmark statement for forensic science, recognise forensic science as a subject in its own right. It sees the need for a good foundation in the science and that this science is carried out within a legal framework.

One of the main attributes of any course relates to the specialist staff who teach on the courses – they need to be good academics as well as staff who understand and ideally have worked within the industry. Secondly, the courses should have access to the 'forensic' equipment and facilities; not just the routine analytical equipment, but also other equipment specifically used within forensic environments from fingermark enhancement to contact trace analysis, to biological fluid identification and analysis. Finally, the institution should also have good links with industry for guest lecturers, site visits and other forms of collaboration, such as research.

All courses must cover the legal framework for expert witnesses as well as professional witnesses, ideally linking with the university law department and having a mock courtroom. Many accredited courses have specialist facilities, for example, Teesside University has a real courtroom, a 10 vehicle laboratory, a 20 station digital laboratory and a 30 room crime scene house.

The students who graduate from these accredited courses should have a good science foundation and understand the meaning of forensic and the framework in which they would operate. Furthermore, students should have an extensive range of transferrable skills, such as communication – written and oral, ability to work on their own and as a team, skills in problem solving associated with critical analysis.

The courses – at full BSc and MSc level – will need to adhere to the QAA benchmark, fundamental science, legal framework and this, of course, will include fingerprints.

4.4.2 Gaining Academic Credit for Vocational Training

The Forensic Centre of the College of Policing has developed a number of specialist courses within the fingerprint domain that it delivers to national and international police forces and other providers of fingerprint evidence. The Forensic Centre is based at Harperley Hall in Durham and provides a state of the art training facility. The Centre works with the Forensic Science Regulator, Skills for Justice and higher educational establishments to ensure the quality and functionality of the training provided. Up until July 2014, the College of Policing and the Metropolitan Police Service were working with Teesside University in order to allow those on the crime scene investigation and fingerprint examiner learning programmes to combine their training and education and be awarded a Foundation Degree in the relevant subject from Teesside University. The requirement from Teesside was that students completed their foundation programme at the College of Policing or within the Metropolitan Police and carried out an additional research project in order to be entitled to the foundation degree qualification. This programme was government-funded, allowing students to opt in at no personal cost or additional cost to their sponsoring

Police Force. Unfortunately, government funding is no longer available for this foundation degree. In the past, the College of Policing has had a similar arrangement for crime scene examiner training with Durham University, and for the Postgraduate Clinical Forensic Medicine course currently run by the College of Policing (designed for doctors wishing to become a Forensic Medical Examiner), is accredited by Teesside University.

4.4.3 Fingerprint Research and Development

Current Fingerprint Research

There is a considerable breadth of fingerprint research and development being carried out within the UK. Some of this research is academic in nature and originates from UK Universities. Other research is carried out by fingerprint practitioners, private industry, or through collaborative research involving a number of different stakeholders. **Appendix 5** provides an example of some of the current research and development that is being undertaken throughout the UK. This is not intended to be an exhaustive list of research; rather the table is intended to give an example of the breadth of research that is currently being undertaken, perhaps providing the basis for potential collaboration with innovators external to the fingerprinting domain. It is acknowledged that there will be considerable additional research and development being carried out within the UK that will not have been included in this table. Additions or alterations to this list would be welcomed for future publication and for inclusion in future versions of this report. Similar to the information in the Databases provided on the Forensic Science Special Interest Group website (https://connect.innovateuk.org/web/forensics/overview), this table is intended to be a useful first point of call for those looking to innovate and collaborate within UK fingerprinting.

There is also considerable research being undertaken in the private sector by industry partners who are actively looking to academia and forensic specialists to bridge the gap between research ideas and bringing such innovation to the market. As well as SIG groups in the UK, Europe has also developed effective knowledge transfer infrastructures. For example, the COST IC1106 EU funded initiative facilitates the exchange of information on research in the fingerprint and wider biometric domain, which engages with industry partners and bodies such as the European Network of Forensic Science Institutes (ENFSI) as well as with the European Division of IAI.

Dissemination of Fingerprint Research

Academic Dissemination of Research

There is a wide range of academic journals that publish fingerprint research. These journals vary in audience, impact, and distribution. Examples of academic journals that may publish fingerprint research include:

Analyst publishes analytical and bioanalytical research that reports discoveries and inventions. It focuses upon the applications of this research and is not confined by traditional discipline barriers, making it an ideal publication for analytical research in relation to fingerprints.

Analytical Methods is the sister journal of Analyst. It publishes reports of early demonstrations of the application of analytical methods that have societal impact, such as fingerprint research.

Chemical Communications publishes new research from across all major areas of chemical research, including chemistry related to fingermarks and their enhancement. The journal is known for its rapid communication of novel research and publishes 100 issues per year to an audience of academic and industrial chemists.

Fingerprint Whorld is the journal of The Fingerprint Society. It is a quarterly, peer reviewed journal that reflects the aims of the society, which are to advance the study and application of fingerprints and to facilitate cooperation among those interested in this field of personal identification. The journal focuses on the theory and practice of fingerprint identification science and associated disciplines. The journal encourages articles containing novel research and review articles across the spectrum of forensic evidence in recognition of its global and multidisciplinary membership.

Forensic Science International is an international, monthly journal dedicated to the application of medicine and science to the administration of justice. As such, it covers a wide breadth of forensic disciplines, including fingerprint research. Forensic Science International is a high impact journal with a large and international readership and distribution.

Journal of Forensic Identification is the bimonthly journal of the International Association for Identification. The journal includes articles on a wide variety of disciplines within forensic science, including latent fingermark processing techniques and fingerprint comparison.

Journal of Forensic Sciences is the peer-reviewed journal of the American Academy of Forensic Science. The journal includes articles on a breadth of forensic science discipline, including the field of fingerprinting.

Law, Probability and Risk is a peer-reviewed journal, the primary objective of which is to cover issues in law that have a scientific element, with emphasis on the statistical and probabilistic issues and the assessment of risk in these cases. Under this remit the journal publishes articles discussing the interpretation of fingerprint evidence, often with a focus upon the statistical aspects of evidence interpretation.

Science and Justice is the peer-reviewed journal of the Chartered Society of Forensic Sciences (previously the Forensic Science Society). Published six times a year, the journal is intended to provide a forum for the communication and publication of original research articles within the forensic science community, including the fingerprint domain.

Practitioner-Based Publications Disseminating Fingerprint Research

Forensic Eye is a publication produced by the Research and Development department at the Crime Academy of the Metropolitan Police, in conjunction with UK policing and the College of Policing. The publication presents topical and important issues that have an impact upon crime and forensic training. The information contained in this environmental scanning publication is included from a number of sources including Government and quasi-governmental bodies, criminal justice organisations, industry, general media sources, and research bodies. It is intended for an internal police audience only and is not generally accessible to external researchers or innovators, although may be circulated to some academic institutions.

Home Office CAST Publications - The Centre for Applied Science and Technology (CAST) publishes a number of documents to communicate the findings of novel research and development within the fingerprint domain. Primarily, fingerprint research underpinning the Fingermark Visualisation Manual is detailed within the Fingerprint Source Book, and both publications are available for download and purchase, respectively. Additional research carried out after the publication of the previous version of the manual was published via the CAST website as additional updates to its content. The new Fingermark Visualisation Manual is published in digital form, meaning that future updates will be direct updates made to its content digitally. CAST publications are not limited to a practitioner audience, but those outside of operational fingerprint development (for example those in academia) will need to purchase a copy of the Fingermark Visualisation Manual from The Stationery Office (TSO).

Further information on the content of the CAST Fingermark Visualisation Manual, published in January 2014, is included in **Appendix 4**.

The *Police Online Knowledge Area (POLKA)* is an online knowledge sharing facility and collaboration tool, which has a law enforcement membership focus. The website is described by POLKA as a 'tool for the policing community to network, ask questions, share insights, discuss ideas, and suggest new ways of working' and is a forum for the dissemination of fingerprint research and development through the 'Forensics' and 'Forensics Quality Standards' communities. Membership of and access to POLKA is restricted and can only be gained by those who have access to the Police National Network (PNN) or are on selected Government Secure intranet (GSi) networks. This limits membership to UK Police Forces and a small number of other agencies.

Police Professional is a UK professional journal that caters for police management, forensic, analysis, investigative practice, police technology, law, operational and strategic policing issues. It has a weekly

distribution to individual and police force subscribers. This publication is read by both managers and practitioners, and while the reader penetration is not exhaustive it still has a high influence within policing.

RECOMMENDATION 1

Dissemination of Research – Bridging the Gap Between Academia and Practitioners

Whilst there are a number of platforms for the dissemination of research within the UK fingerprint community there is a distinct divide between the readership of and access to these media, with a focus either upon academics or practitioners. Subscription to academic journals is costly and is not routinely procured by UK police forces, whereas academic institutions provide access to a full range of journals and publications. Therefore, it is challenging for practitioners to remain up to date with recent research and innovation occurring outside of their own organisation, across the country, or across the globe. The journals of professional bodies such as the Fingerprint Society or the Chartered Society of Forensic Sciences go some way to bridging this divide through offering access to their journals as part of membership of the society, allowing practitioners affordable access to these publications. However, it is unlikely that practitioners will be members of all such professional bodies and as such will still be unable to access research not published in the journal of their chosen society or body.

Similarly, it is the case that practitioner based research and development remains primarily internal to practitioner groups and is not readily available to academia or industry outside of its place of publication due to restrictions on access. The availability of the CAST Fingermark Visualisation Manual to an external audience goes some way to address this barrier, but it is still the case that smaller scale, local practitioner research is not disseminated in a forum accessible to an audience external to policing.

It would seem that this division may create barriers to innovation as there is a lack of continuity of knowledge; practitioners miss out on knowledge and understanding of academically-driven research that may be of benefit, and academic researchers fail to gain an understanding of the current research output of, and challenges facing, practitioners. This being the case, there is a danger that academic research may miss the mark in terms of real world problem solving and practical application to the fingerprinting domain, whilst practitioners may miss out on research vital to their own innovation and development.

It is recommended that there is a further drive to facilitate the multi stakeholder dissemination of research and development within UK fingerprinting. It may be the case that the Forensic Science Special Interest Group could form a platform for an environment scanning publication that could combine a summary of research output from academic journals with that of practitioners and industry stakeholders. This could take the form of a regular SIG publication, or more of an interactive forum for the sharing of research and development and innovation open to all stakeholders who sign up via the Forensic Science Special Interest Group website.

4.4.4 Examples of Multi-Stakeholder Innovation and Collaborative Approaches

Two case studies that provide examples of successful collaborative work between practitioners, academia and industry partners within the fingerprint domain are provided in **case studies 3 and 4**.

CASE STUDY 3
Taking Fingerprint Research and Development to Market

Dr John W. Bond OBE

My association with Consolite Forensics began in 2009 after my then employer (Northamptonshire Police) had patented a new technology I invented to visualise fingerprint ridge detail on metals subject to environmental extremes and, specifically at the that time, spent brass shell casings. Consolite were already a well-established business and specialists in all aspects of night vision lighting design, manufacture and supply to the military worldwide. Consolite was looking to diversify their business interests and this patent had caught their interest. Through Northamptonshire Police's Patent Attorney, an agreement was reached whereby Consolite would design, manufacture and sell a commercial version of the equipment developed at Northamptonshire Police. Supplying goods and services to law enforcement agencies was a new area for Consolite and so there was a steep learning curve, not only in commercialising what was, essentially, laboratory technology, but also in understanding the police use of forensic evidence. This commercialisation proved more challenging than was initially anticipated although the product (known as CERA LT) is showing positive results. Another challenge was gaining acceptance of this technology in a court of law and a significant step forward was made in April 2012 when the Superior Court of California in the US accepted evidence obtained using this technology. During this time, I retired from Northamptonshire Police and took up a position with the University of Leicester. The good working relationship I had with Consolite enabled this association to continue, despite changing employers.

Consolite (now known as Consolite Forensics) was keen to develop other forensic products and, as a result of our good working relationship, was happy to work with the university. This led to the commercialisation of a novel method I developed for visualising fingerprint ridge detail on thermal paper (the type of paper widely used for printing receipts). This technology, originally patented by the university, has been developed by Consolite Forensics into their Hot Print System or HPS.

This good working relationship between the university and Consolite Forensics continues with the ability for me to contribute to the development of their forensic products by investigating scientific queries raised by Consolite, their agents or users of the systems. Five years on, this is probably the strongest part of the continuing relationship whereby Consolite Forensics lead on product development and refer scientific matters to me for investigation, the results of which can then, in turn, inform product development. The before and after stages of product development are shown in Figure 4.

What has worked well:

- Having well defined roles in the relationship separating understanding the underlying science from the commercial development.
- Understanding the requirement to produce equipment that meets the needs of forensic laboratories (ease of use, fulfils a need etc.).
- Understanding where gaps in existing knowledge or technology exist and then focusing on those.

What has worked less well:

With hindsight, a better entry product for Consolite Forensics would have been HPS as the development time was much less than for CERA LT. Therefore, a new player in the forensic market place should perhaps look for a relatively low technology and low cost 'starter' product.

Northamptonshire Police was much less experienced at working with a commercial partner than is the university, where dedicated staff exists to develop the relationship. This led to occasional misunderstandings over the roles and responsibilities of those involved in the agreement.

Converting laboratory technology into a commercial system that meets the needs, skills and operational demands of users has been at times problematic, particularly so when there is a need to automate into commercial equipment what has been a hand crafted laboratory procedure.

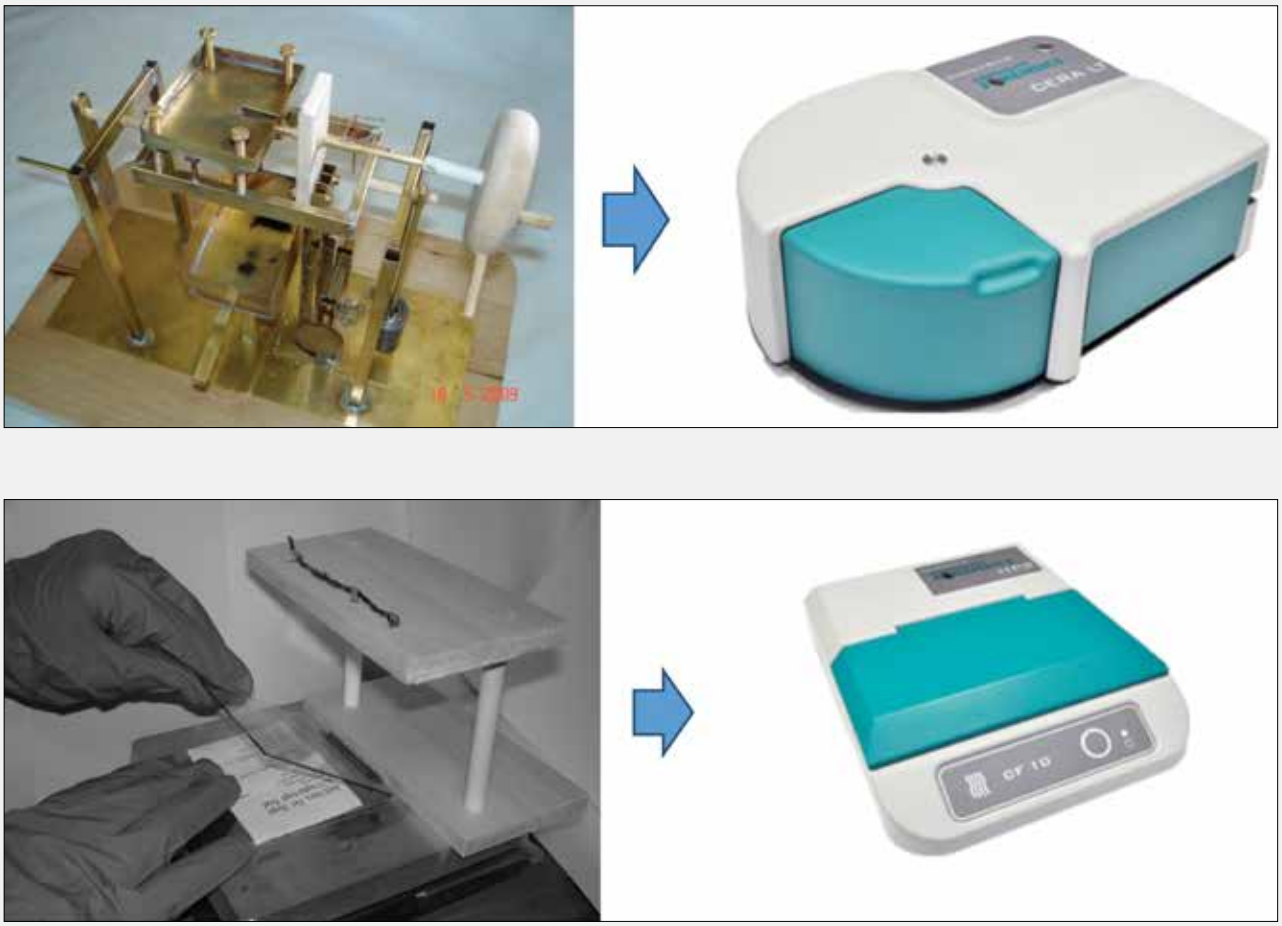

Figure 4 – CERA LT and HPS –from laboratory to commercial instruments.

CASE STUDY 4

The Development of FIBRE – An Academia, Industry & Practitioner Partnership

Many Fingerprint Bureaux are introducing remote transmission technology into their workflow. This will mean that fingerprints can be transferred from the crime scene and laboratory, and then processed electronically, providing a more efficient and rapid service and removing the need for paper fingerprint records.

A system called the Forensic Information Scanning Hub (FISH) was implemented by AGX, initially under the leadership from Sussex Police. AGX later approached Surrey and Sussex Police with an interest in starting a new project. At the same time, Warwick Warp approached Surrey and Sussex Police. Warwick Warp was a company set up within Warwick University involving researchers who had been carrying out work on fingerprint algorithms, one of whom had been involved in the production of the National Automated Fingerprint Identification System (NAFIS) within the Police Information Technology Organisation (PITO). Warwick Warp evolved to become Pattern Analytics and, through Surrey and Sussex Police, teamed up with AGX and began working on the Forensic Identification Bureau Remote Evidence System (FIBRE) remote transmission system.

The design of FIBRE, provides two simple components, the HUB (server), which sits at the centre of the system managing the data transfer from remote locations to the bureau and also input from fingerprint practitioners, chemical treatment labs and other departments. The NODE is the access point software, which allows the user to log to in their specialisation and either load data or process for final identification.

AGX provide a technical specification for Force IT departments, for PC's, Monitors and graphics cards. AGX also provide FIBRE hardware terminals, suitable for the remote location sites for CSI's to load case images etc.

The costing of the FIBRE Systems is structured on the number of NODE licences required together with the HUB (server) licence, which provides a complete system and allows remote transmission and all the data processing required.

The expansion of functionality and ISO compliance requirements is structured over a 3 year phased programme, which is inclusive within the comprehensive service support package for years 2 & 3

Partnership with Surrey and Sussex means that the force provides a test ground for the software and for software development while Pattern Analytics and AGX absorbs much of the development risk around funding. In this way, the relationship was successful at delivering a product that was fit for purpose and cost effective to the Force. However there is always a built-in risk that the roll out may not be entirely smooth in its infancy as Surrey and Sussex will be directly exposed to the development and testing phase.

Software such as FIBRE needs to be readily and easily implementable in an operational setting. It needs to be user friendly and require minimal user training. A close working relationship with a software developer allows the end product to tick these boxes.

Surrey and Sussex also carry out validation of the system during development and base some aspects of validation on peer reviewed validation of image processing undertaken by the University of Westminster and stakeholders at the East Midlands Police Fingerprint Bureau, who have pioneered the use of remote transmission.

Scene of Crime Officers, the fingerprint enhancement laboratory, and fingerprint examiners have all been involved in the design and testing of FIBRE. The roll out of the system will receive dedicated IT project management support within the force.

Future additions to FIBRE are also planned as it would be beneficial to have a gateway between IDENT1 and the newly digitised ten-prints and to have a method for sending National Institute of Standards and Technology (NIST) files via the remote transmission system to outside agencies such as Interpol.

Surrey and Sussex are also looking to improve knowledge transfer within remote transmission by setting up a FIBRE national user group to share information, standards and experiences.

FIBRE is an example of a success story of university-based research that has led to commercial distribution through working closely to meet the needs of the practitioner end user. Whilst there is some inconvenience and disruption to practitioners in the testing phases, this approach insures the procurement of a system that is fit for purpose and allows consultation with ground level staff throughout the process, increasing practitioner buy in to the new system.

5. Communication and Knowledge Transfer within UK Fingerprinting

This chapter provides an insight into the current communication channels within UK fingerprinting.

In particular two types of communication and knowledge transfer are focussed upon:

- Local and national forums for communication for Fingerprint Enhancement Laboratories and Fingerprint Bureaux; and
- Communication between Fingerprint Enhancement Laboratories and their partner Fingerprint Bureaux.

Existing formal communication forums are described and recommendations are made for improved communication between fingerprinting stakeholders.

5.1 Local and National Forums for Fingerprint Communication and Knowledge Transfer

5.1.1 The Recent History of Formal Communication within UK Fingerprinting

Figure 5 represents the changing nature of formal communication forums within UK fingerprinting from 2008 to the present day.

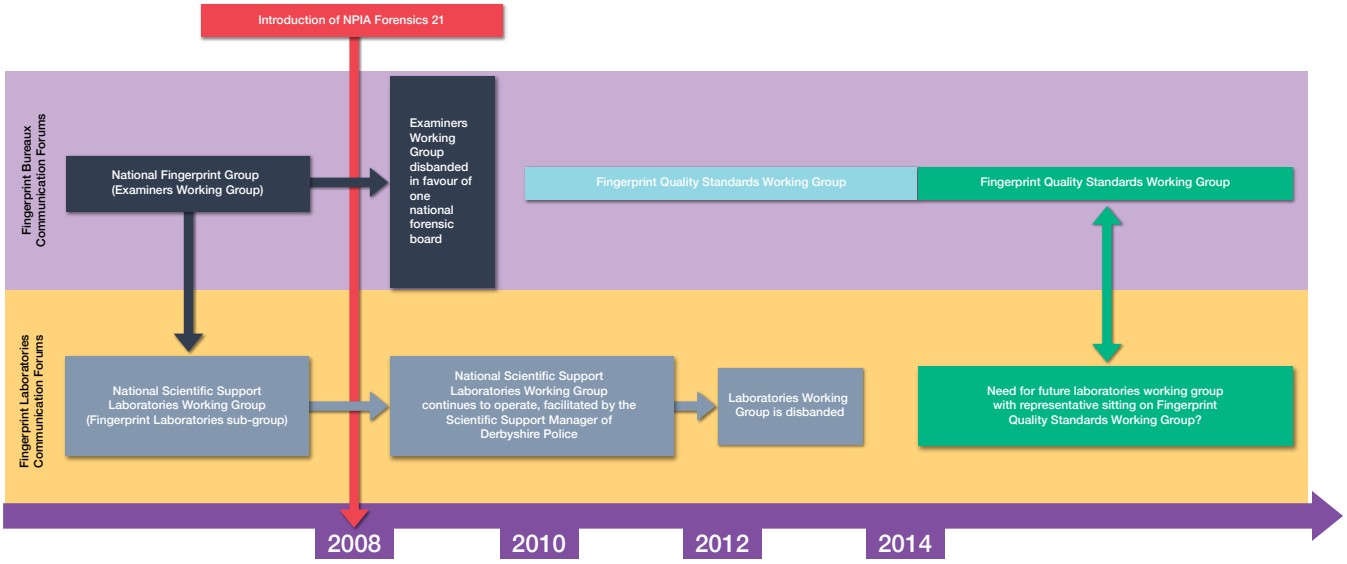

Figure 5– The history of formal communication forums within the fingerprint community

Initially the National Fingerprint Group was set up as a working group encompassing both the Fingerprint Laboratory and Fingerprint Bureau aspects of workflow. This group was then split to form the Examiners Working Group and, a sub group of this, the National Scientific Support Laboratories Working Group. This provided separate platforms for interaction for Fingerprint Enhancement Laboratories and Fingerprint Bureaux. At the time this separation was considered important as it gave the laboratories their own voice and an opportunity to be recognised as an important entity in their own right, separate from the Fingerprint Bureau. When The National Policing Improvement Agency (now disbanded) Forensics 21 programme was introduced in 2008 the National Fingerprint Group disbanded. The National Scientific Support Laboratories Working Group continued to operate. Regional representatives of fingerprint enhancement laboratories attended these meetings and CAST were also represented, providing a continued forum for discussion at a national level.

However, the Laboratories Working Group was disbanded in 2012 and national meetings of regional representatives within fingermark enhancement ceased.

Whilst the Fingerprint Quality Standards Specialist Group formed in 2010, providing a continued national forum for Fingerprint Bureau communication, there is currently no formal communication forum for Fingermark Enhancement Laboratories, although there may be some meetings of regional representatives occurring within areas in which individuals have driven this interaction.

5.1.2 Current Forums for Communication

Although, as previously stated, the fingerprint community is currently lacking a national forum for communication dedicated to Fingermark Enhancement (either at crime scenes or in laboratories), there is a variety of communication channels currently in operation within UK fingerprinting. Examples of these are provided below:

The Fingerprint Quality Standards Specialist Group

In 2010 the Fingerprint Quality Standards Specialist Group was set up following the Scottish Fingerprint Inquiry, with the initial aim of producing a fingerprinting annex to the Forensic Science Regulator's code of practice and conduct, so as to ensure the reliability of fingerprint evidence. As such, the focus of this working group is fingerprint comparison and quality standards within Fingerprint Bureaux, rather than fingermark enhancement and Fingerprint Laboratory processes and procedures. The group routinely meets quarterly but also splits into focus groups that may meet more regularly to focus on particular tasks and work streams.

The terms of reference of the Fingerprint Quality Standards Specialist Group as published by the FSR are to:

- Define the scope of the review of fingerprint quality standards, with options for later extension of this scope;
- Review the current options for accrediting fingerprint examination to ensure suitable quality standards;
- Recommend an option that best achieves quality standards in the delivery of fingerprint examination and expertise to the Criminal Justice System;
- Oversee the processes for monitoring and enforcing fingerprint quality standards, including relationships with other bodies, within forensic science;
- Propose means of remedying any shortcomings, distinguishing between measures which fall within the remit of the Regulator and those which do not; and
- Make such other recommendations as appear appropriate.

Key areas of development and work plan for the group are:

- Reporting outcomes from fingerprint examination;
- Development of a Fingerprint Terminology, Definition & Acronyms;
- Production of a fingerprint Primer to aid the courts;
- Development of an annex on fingerprint examination to the Regulator's Codes of Practice and Conduct to include validation, organisational competence, practitioner competence, and impartiality;
- Consultation on the annex on fingerprint examination to the Regulator's Codes of Practice and Conduct, firstly within the fingerprint profession, followed by public consultation with interested parties (Association of Chief Police Officers (ACPO), Crown Prosecution Service (CPS), Ministry of Justice, judiciary, academia etc.);
- Collaboration with United Kingdom Accreditation Service (UKAS) and the development of a pool of Technical Assessors; and
- The development of a UK Proficiency Testing Scheme.

The Fingerprint Quality Standards Specialist Group is currently attended by:

- A representative of the Forensic Science Regulator (FSR);
- A representative from the Crown Prosecution Service (CPS);

- A representative from UKAS;
- Fingerprint Bureau Heads from:
  - ◊ West Yorkshire Police;
  - ◊ West Midlands Police;
  - ◊ Greater Manchester Police;
  - ◊ Scottish Police Authority;
  - ◊ The Metropolitan Police Service; and
- A scientific advisor (Director of the Centre for Forensic Science, University of Strathclyde).

The group is chaired by the Metropolitan Police Service Director of Forensic Services on behalf of the Forensic Science Regulator.

Examples of the past and future projects of the Fingerprint Quality Standards Specialist Group are provided in **Appendix 6**.

Fingerprint Strategic Network

The Fingerprint Strategic Network is a national forum for Fingerprint Bureau communication. It is made up of regional representation from the various ACPO regions with representation from Police Scotland, PSNI and the National Crime Agency. Minutes of these meetings are published via POLKA. There is also an IDENT1 Representatives Meeting (IRM) which is an off-shoot of the FSN to purely focus on IDENT1 issues.

A recent development is the creation of a Fingerprint Governance Meeting which is in its early stages of development and is intended to be a very strategic meeting made up of key stakeholders, which is hoped will play a role similar to that of the DNA Strategy Board.

European Network of Forensic Science Institutes (ENFSI)

The European Network of Forensic Science Institutes has 64 member laboratories in 36 countries and is recognised as a forensic science expert group aimed primarily at laboratory practices and personnel. The purpose of the network is to 'share knowledge, exchange experiences and come to mutual agreements within forensic science.

ENFSI is a growing organisation looking to gain members throughout Europe whilst maintaining its credibility as an expert organisation, establish relationships with similar organisations, and encourage member laboratories to comply with international best practice standards.

ENFSI describe their activities as:

- Organising meetings and scientific seminars, collaborative studies and proficiency tests;
- Advising relevant partners on forensic issues; and
- Publishing best practice manuals of forensic terms in several languages.

ENFSI is made up of a number of domain specific working groups, including a fingerprint working group: The **European Fingerprint Working Group (EFP-WG)**. The EFP-WG holds regular meetings, which aim to develop professional relationships, raise awareness of and collaborate in research and development, promote quality management through the publication of a Best Practice Manual, and support collaborative testing and accreditation within the fields of fingerprint detection, imaging and comparison.

The group is organised and managed by a steering committee and is further divided into two subgroups; Detection (members who specialise in the location and recovery of fingerprints), and Identification (Fingerprint Examiner members). Additional subgroups are formed to deal with specific issues.

ENSFI also has three standing committees that tackle the general areas of quality and competence, education and training, and research and development across forensic science (outside of the domain specific working groups).

UK membership of the European Fingerprint Working Group includes representatives from the National Crime Agency (holding full membership), the Metropolitan Police (holding full membership), and CAST (holding associate membership)). A requirement for full membership is to be conducting in-house research and operational casework, and, as a result, CAST only holds associate membership due to a

lack of routine operational work.

Police Online Knowledge Area (POLKA)

As previously mentioned in relation to research and development, The Police Online Knowledge Area (POLKA) is an online knowledge sharing facility and collaboration tool, which has a law enforcement membership focus. It is utilised by practitioners within the fingerprint domain as a communication and knowledge transfer tool. Within the POLKA community there is a 'forensics' sub community, and within that sits the 'laboratory quality standards community', which has membership at practitioner level. Communication between fingerprint practitioners occurs across police forces through this platform.

RECOMMENDATION 2

A National Organised Forum for Fingerprint Enhancement Laboratory Communication and Increased Interaction between Laboratory and Bureau Stakeholders

There is currently a lack of an official platform for Fingerprint Enhancement Laboratories to communicate and share knowledge on a regional or national level. Fingerprint Bureaux have a platform for national discussion and for national interaction with the Forensic Science Regulator, Crown Prosecution Service, and academia through the Fingerprint Quality Standards Specialist Group and the Fingerprint Strategic Network. Fingerprint enhancement laboratories, however, are not represented on the Fingerprint Quality Standards Specialist Group and, following the disbanding of the National Scientific Support Laboratories Working Group, do not have an equivalent national forum.

Whilst the division of working groups for Laboratories and Bureaux was once thought to be a favourable approach in the interests of providing Laboratories with their own identity and recognising the specialist nature of their role, it would now seem that this divide might in fact, be detrimental to the working relationships of Laboratories and Bureaux. There are no national forums jointly and formally attended by Laboratory and Bureau representatives, and these two disciplines are largely seen as separate entities due to the differing nature of their specialisms. However, it could be argued that a more unified approach would be beneficial to the evidential processing of fingermarks as the two disciplines contribute to the same core process, and the working practices and requirements of one discipline can have a direct effect upon the other. This is particularly important at a time when many police forces are looking to introduce new technology and systems to allow more rapid and cost effective processing of evidence, which will require consistency in their application.

It is recommended that there should be a forum for communication for Fingerprint Enhancement Laboratories at a national level. It may be the case that the Forensic Science Special Interest Group is in a position to help to facilitate the set up and organisation of this group. It would seem to also be beneficial that a representative from this group would sit on the FSR Fingerprint Quality Standards Specialist Group and act as a liaison for the two groups to allow collaborative discussion where this was deemed to be beneficial. There should also be a suitable mechanism in place for the dissemination of the work of the two groups to practitioners at a ground level. Ideally such a group should also extend to those practitioners engaged in recovering fingermarks at crime scenes.

5.2 Communication between Fingerprint Enhancement Laboratories and their Partner Fingerprint Bureaux

Historically the roles of CSI, laboratory practitioner and fingerprint examiner were combined; and one person was responsible for the recovery of marks from scene, enhancing them in the laboratory and any subsequent comparisons. In recent decades these have become individually distinct roles in the UK, which in terms of professionalism and expertise is a good thing, however there should be a greater understanding and appreciation of each of the roles within the Criminal Justice System.

In some parts of the world this multi-disciplinary approach is still in existence.

Police Force Fingerprint Services across the country have varied structures and divisions of responsibility. This is increasingly the case given the structural changes and mergers of Fingerprint Services as police forces strive to make a more efficient use of their resources in times of fiscal pressure. It may be the case that the Fingerprint Bureau and the Fingermark Enhancement Laboratory within a Scientific Support Department are positioned alongside each other within the structure of the organisation under the management of the same individual (often the Scientific Support Manager). However these two services are separate entities within the business with differing management structures. Some Fingerprint Laboratories and Bureaux sit physically within the same location, building or facility, but others work at a geographical distance from each other, which is particularly likely if a merger between the Scientific Services of two or more Police Forces has occurred.

The internal structure of a police force can affect the mechanisms of cross-departmental communication in place, and has the potential to add or remove barriers to communication. With organisational change there can be tensions between the positioning of departments within the new structure of the organisation. For example, it may be the case that the positioning of the Fingerprint Laboratory is disputed as a capability that could either sit under Scientific Services or Technical Support, or it may be that the structural relationship between the Laboratory and Bureau is disputed.

Levels of communication and collaboration between Laboratories and Bureaux vary between Police Forces. These relationships can be affected by the structure, physical location, and culture of the organisations in which they sit and also by the internal managerial approaches taken, the formal processes for interaction that are in place and the workforce at the ground level. A recommendation for a working relationship between a Fingerprint Laboratory and Bureau is provided in **Recommendation 3.**

RECOMMENDATION 3

Considerations for an ideal relationship between Laboratories and Bureaux

The relationship between the fingermark enhancement laboratory and the fingerprint bureau should recognise that the bureau are effectively the customer for the outputs of the laboratory, and therefore those outputs need to be fit for purpose. In some cases, a separate imaging unit may also be involved in providing the outputs to the bureau and so a three-way relationship may exist. It is also necessary for the bureau staff to appreciate that the laboratory is more than a 'factory' for the delivery of marks and that selection of appropriate enhancement and imaging processes is not a trivial exercise.

An ideal relationship between the laboratory and bureau should be open and collaborative, and involve as much two-way communication as possible. It is recognised that laboratories and bureaux are increasingly located on separate sites, which may make face-to-face communication more difficult, but alternative means should be sought to maintain interaction. Practitioners in the laboratory and the bureau should have at least a basic understanding of the work of the other and be able to communicate in the same working language.

Laboratory staff should understand what features identification specialists use in their comparisons and be able to form judgements about whether enhanced marks are sufficient both in terms of amount and quality of detail. Bureau staff should understand the range of processes by which marks may be enhanced and the appearance of marks enhanced using them. Most importantly, both sets of staff should assist each other in building an understanding of situations where misinterpretations can arise, for example where marks could appear reversed in terms of orientation or colour, or distorted in size, all of which could lead to potentially identifiable marks being missed.

As a consequence, laboratory staff should be proactive in supplying any additional information to the bureau along with the image of the mark that they believe may be required for it to be correctly interpreted. Such information could include overview images of the items showing positions of the mark(s), colour images of the mark, particular notes about an unusual surface or an unexpected mode of development. Bureau staff should be able to act as an intelligent customer, noting where the image of the mark may have unusual features and being able to request additional information or images from the laboratory where they believe it is required to inform the comparison process.

Bureau staff should also recognise that the images they are presented with are representations of the original mark, which may be degraded in quality through operations such as converting from colour to greyscale, scanning, and printing. It should be possible for bureau staff to request viewing of the mark in situ on the original item if they believe that this will provide more information than the image they are presented with. Awareness of the potential for contextual influence at this stage and how mark complexity can impact upon decision-making should guide the methodology by which images are viewed.

6. Innovation for the Future – Challenges and Goals

As described in Chapter 1 of this report, there are a number of challenges facing fingerprint evidence in the UK, and at a global level. The scientific validity of fingerprinting has been called into question and so the discipline must work hard to ensure that it is transparent and fit for purpose. Equally, fingerprinting must continue to develop as a science, and must not neglect innovation that will lead to more effective, quicker or more cost efficient methods of fingermark development and fingerprint identification.

6.1 The Current and Future Challenges to UK Fingerprinting

The most fundamental challenge to UK fingerprinting is to maintain the credibility of fingerprints as a means of identification. Recent misidentifications and disputed identifications (The Fingerprint Inquiry Scotland, R v Smith) raise concerns about the reliability and robustness of fingerprint evidence, and practices need to be adjusted so that the public, and legal system retains confidence.

Fingerprints are probably the only form of forensic evidence about which opinion-based interpretation is still regarded as absolute. A significant body of research has been collected regarding probabilistic approaches, but if such an approach is to be implemented in the UK, it needs to be properly validated and introduced in a way that courts, fingerprint examiners and juries can understand.

Another challenge facing fingerprinting is to provide an IT and database structure that facilitates communication between different stages in the fingermark evidential process (crime scene, laboratory, imaging and identification) and rapid transfer of images and information. The benefits of rapid transmission of images from the crime scene to the bureau have already been demonstrated, but the current database does not readily allow images to be rapidly loaded for searching.

In addition to improving communication between practitioners at different stages of fingermark recovery, there is also a need to improve communication between fingermark specialists and other forensic practitioners to properly prioritise evidence and develop integrated forensic recovery strategies. This presents a challenge in the current environment of mergers between Police Force scientific functions and the number of different forensic service providers in the commercial market.

In the current financial austerity environment there is also a need to reduce the time, cost, and resource burden of fingermark processes while maintaining and improving quality. This could be addressed in a number of ways; doing more processing at the crime scene, identifying lower cost alternatives to expensive chemicals, or introducing more rapid development processes. It may also be possible for forces to build relationships with academia or other research institutions for occasional access to specialist equipment as opposed to operating and maintaining such facilities themselves.

A final challenge for the fingerprinting domain is to communicate to a broader academic and industrial community that fingerprinting is still by far the most widely used identification method (as opposed to the increased press coverage given to DNA), and that many challenges still remain. By focusing the attention of researchers and industry on these challenges, it may be possible to identify pre-existing solutions that have been developed for other applications but can be readily adapted for use in fingerprinting.

The remainder of this chapter provides a number of case studies that describe:

- examples of potential transferable ideas and solutions from other stakeholders and domains; and
- examples of on-going research and innovation and discussion of some of the future challenges faced by fingerprinting in these areas.

Finally there is a brief discussion of the current position in relation to funding for fingerprint research and innovation in the UK.

6.2 Transferring Knowledge and Experience from External Stakeholders

There is a need for the UK fingerprint community to look beyond an existence as a silo domain and to be

open to the application of a wider innovative approach and the potential transfer of solutions from other organisations and domains. Case studies 6 and 6 provide examples of models that may be of interest or benefit to UK fingerprinting stakeholders.

CASE STUDY 5

The Dutch National Police Services Agency; A Novel Approach to Fingerprint Comparison Workflow

The Dutch National Police Services Agency has reviewed their internal processes in order to tackle the issues of bias within fingerprint comparison. The national police force is made up of ten regional police units and a central unit, located in The Hague. The force uses the AFIS system and has a criminal database of over 1 million flat and rolled prints.

In 2007, the Police Force needed to replace their fingerprint systems and so took this opportunity to look closely at their processes and structure to ensure that the new system would aid in meeting the challenge of minimising the bias within fingerprint comparison that they had identified.

One of the major issues that was identified, was that examiners were exposed to background information about each case and information regarding suspects in the case prior to carrying out a comparison. Such information was known to be potentially biasing to the examiner. It was also identified that the information provided was often emotive, and that there was the potential for examiners to feel the pressure of potential failure along with pressure from their line manager to achieve results.

It was also the case that examiners had access to the exemplar (suspect's) print during the analysis of the crime scene fingermark. This has the potential to lead to recognition of details in the crime scene mark that the examiner has only seen in the exemplar print, biasing the subsequent comparison.

Bias was also identified in the verification process of ACE-V. The examiner making the verification was shown all information in relation to the print (including the decision of match or exclusion made by the previous examiner), leading to the potential for confirmation bias. It was also known which examiner had carried out the previous comparison meaning that issues of hierarchy and organisational culture could play a role in decision-making.

As a result of these issues it became apparent that the responsibilities of a fingerprint examiner needed to be divided up. It was recognised that only essential background information should be provided to those to whom this information was essential and should be kept close to the investigative team. Such information was not required by the examiner making a comparison.

In order to better use contextual information the police divided the information in relation to a latent mark into three categories:

Source level: The donor or source of the fingermark

Activity level: The activity of the latent fingermark within the case, e.g. the location of the mark on a knife

Case level: The wider role of the fingermark within the case

The fingerprint comparison process was also divided into two distinct phases:

Phase one – Investigation: This involves quality assessment of a latent mark and assessing the activity level information in relation to the mark. This stage includes the initiation of an AFIS search, determining the priority of the fingermark (for example, according to the severity of the crime type it relates to), and assessing the number of AFIS hits that will be considered.

Phase two – Identification: Searching for a connection with the donor.

Three different levels of Fingerprint Examiner were also created in order to distinguish between roles:

Level 1 Fingerprint Examiners

Level 1 Fingerprint Examiners input information regarding the latent fingermark. They will know the background information regarding the enhancement of the mark so as to make any necessary adjustments to the image according to the development methods used (for example reversing the image or converting it to grey scale), and will determine whether the mark is that originating from the friction ridge skin of a finger or of a piece of palm.

Level 2 Fingerprint Examiners

Level 2 Fingerprint examiners are specialists in searching using the AFIS system and determining the levels of an AFIS match to be used.

Level 3 Fingerprint Examiners

Level 3 examiners are specialists in the identification process and may also be responsible for coaching level 1 and 2 examiners.

Police fingerprint services were restructured in order to allow for a system that meant that the newly divided levels of information could be managed and that these phases of the comparison process could be accommodated into a workflow.

Responsibilities are now divided between the regional and the central fingerprint units. Level 1 and 2 examiners at the ten regional units that have AFIS access are tasked with the Phase 1 activities of inputting latent fingermarks with the knowledge of the case, carrying out a quality assessment of latent fingermarks, and prioritising the level of AFIS search that should be undertaken. This is deemed to be the ideal location for this task as it means that the examiners inputting this initial data are in close proximity to the investigative team and know the role of the mark in the case (the activity level information).

As a result of the regional input of fingermarks, Level 3 examiners in the central unit can then access the marks without the associated contextual information. The first role carried out by fingerprint examiners in the central unit is the evaluation of an AFIS search result. If there has been no ‘hit’ then they will carry out a manual search for the fingermark. When carrying out the analysis process, the system used only allows the examiner access to the latent fingermark. This ensures that the analysis of the latent mark is carried out in isolation of the comparison print. The examiner must record their analysis on the electronic system and colour code the characteristics they believe to be visible in the mark according to their certainty. Once the analysis has been logged the examiner can access the exemplar print and carry out a comparison. If there are any additional characteristics that they now believe to be present in the latent mark (having seen these in the exemplar) they are allowed to record these but the colour used will indicate that these point were determined at this stage in the process. If the examiner believes that the two prints are a ‘match’ then this is recorded in the system as a fingerprint match. At the match stage this information can be fed back to the investigative team to inform an investigation but is not a definitive identification.

The latent print and the exemplar compared by the examiner are fed back into the system and picked up by a second examiner. Without any knowledge of the previous comparison, the second examiner will analyse the latent mark in isolation and then the system will release the exemplar print for Comparison. If the two examiners determine a match between the mark and the print then this is recorded as an identification. In this way the Dutch National Police Services Agency follows a double blind process, essentially carrying out double ACE, instead of ACE-V.

Should the two examiners not agree upon a match or exclusion then three examiners will independently analyse and compare the latent mark and print and will then discuss their conclusions

as a panel. Any examiner on this panel is able to veto the process if they believe they are not able to make an identification. There is no hierarchy to this panel in order to minimise bias at this stage.

The implementation of a system that controls access to contextual information has allowed the minimisation of cognitive bias within fingerprint comparison and has enabled more transparent reporting of fingerprint evidence, since every stage of the process in logged. The restructuring of fingerprint roles and responsibilities has led to a reduction in overall staffing costs, while the job satisfaction of examiners has been maintained through allowing regional examiners of an appropriate level to carry out comparison for case work from other regions thus maintaining their overall skill set.

CASE STUDY 6

The British Transport Police Model of Creativity and Innovation: Enabling Innovation From the Ground Up

The British Transport Police (BTP) is focussing on harnessing creativity and innovation from its employees in order to solve key problems within the business, through the creation of a model, which asks directly for innovative solutions from ground level staff. This model was born out of interaction between the BTP and academia and has its roots in scientific research into creativity.

While studying for an MBA qualification at the University of Bedford, a senior stakeholder within the BTP became aware that the practices of the organisation were likely to be killing creativity within it. As a result, that stakeholder suggested a pilot scheme aiming to increase innovation within his own area of policing, at a local level.

The process followed to achieve this aim was as follows.

The BTP trained a number of facilitators (these were ground level police staff or police officers at sergeant level).

The question ‘how can we raise morale within the British Transport Police’ was set by the management of the locality. This question was selected as a starting point for an initial focus group as an area that all staff could relate to and engage with. Subsequent questions were based more upon the strategic direction of the force, for example ‘how can we reduce theft on the railways?’ or ‘how can we encourage diversity within the BTP?’

A random selection of ten ground level police officers and staff from across the workforce were nominated to take part in an innovation workshop. Participation was mandatory. Participants were told the question for discussion prior to the workshop in order to allow time for consideration of the problem and enable discussion of the problem with colleagues.

The focus group was held and ideas were generated by the attendees. These were recorded in a number of ways, including the use of a wall of Post-it notes. The intention was that the creativity came from the nominated staff and that an innovative angle was placed on this by the facilitators. Chatham House Rules applied to this process, reducing the inhibitions of the contributors. The diversity of the attendees ensured that problems were considered by those who may not usually be directly affected by the issue, allowing a fresh approach to be taken.

After the focus group the facilitators held a ‘wash up’ session during which any ideas which were not considered to have scope for implementation were removed from the process. The aim of this session was also to group the ideas generated into themes for discussion, as this approach has been found to encourage creativity.

The ideas were then presented within the themes identified, to a panel consisting of the senior stakeholder who had posed the question for discussion, the facilitators of the focus group, and an internal media representative. The panel discussed the ideas around the themes in which they were presented. The outcome of this discussion was to categorise ideas as either:

- Ideas that the panel had believed were already being carried out within the organisation and were straight forward to implement;
- Ideas that had already been carried out in the past or were currently being carried out, and so were not pursued further;
- Ideas that were quick fixes and could be implemented rapidly; or
- Ideas that were not quick fixes to the problem but led to longer term projects.

The media representative on this panel was important, as feedback of the uptake of ideas to ground level staff was crucial for the continuation of the process. Such feedback reassures staff that their ideas are being listened to and acted upon, and feeds the cyclic nature of the project. The initiative now has its own logo, branding, and intranet site so as to ensure the consistency of this feedback.

After an initial pilot phase the incentive was rolled out to area commands across the BTP and area commands are now responsible for driving incentive. The scheme has been running nationally in this way for approximately eighteen months, and during this time approximately 100 facilitators have been trained and a number of ideas have been implemented. A number of 'Super-panels' have also taken place which bring together ideas from across a number of regions through inviting regional champions to present their ideas at the Super-panel. The idea behind these panels is to give the scheme a competitive edge between regions. The creativity and innovation process has also been used as a tool to gain ideas from the workforce prior to business change and restructuring.

The initiative is cost neutral; the facilitators carry out this role on top of their day jobs and no posts have been created to administer the scheme.

Examples of success stories that have resulted from the process include:

'How should we reduce theft from passengers on the London Underground?'

Whilst discussing this question at the workshop the issue was raised that officers did not have access to a suitably high resolution collection of images of pick pocket offenders and that the images that they did have were not up to date. To implement new national systems to solve this problem would have been too costly, but instead, televisions were purchased for the control rooms and staff rooms and up to date images of offenders were circled on these displays. This has been highly successful in raising officer's awareness of offenders and has also raised the awareness of police staff who use these communal areas.

'How can we reduce bureaucracy within the organisation?'

Whilst discussing reducing bureaucracy at a workshop it was suggested that the standard operating procedures and policy documents of the organisation tended to be lengthy and inaccessible. As a result a longer-term project was carried out to split up the policy documents and to input them on to a dedicated webpage in a form in which members of staff can ask specific questions and be directed to the appropriate section of the document via a search engine. This means that staff can gain quick access to the information they require without having to read an entire lengthy document.

'How can the force better communicate with its staff?'

It was discussed at this workshop that in businesses such as pubs, restaurants, and service sta-

tions advertisements are placed on the doors of toilet cubicles. This idea led to the development of 'Loo News' a communication that is posted on the toilet doors of BTP Headquarters. The publication serves a range of communication needs and includes the creativity and innovation bulletins that describe the outcomes of the working groups.

Challenges to the innovation program

Whilst this BTP innovation initiative has been a successful scheme, a number of challenges have been identified along the way:

- If the stakeholder responsible for driving the process at a regional level does not fully buy in to the scheme then its success is greatly reduced. The BTP is looking to solve this problem through recruiting leaders for the programme through the BTP leadership academy.
- If communication is not successfully managed at the end of the process, staff do not receive the feedback necessary to boost morale and increase enthusiasm for the scheme. Having a media representative at all panels helps to ensure successful communication.
- The right question needs to be set. It needs to be possible to implement solutions to the problem, so there needs to be buy-in at the right level in order to facilitate this.
- Running out of questions can be a problem. It is important to ensure that the process does not become repetitive and disengaging.

RECOMMENDATION 4

Ground Level Innovation

The British Transport Police model of innovation and creativity has been shown to be a successful approach to drive cost neutral innovation within the organisation. It has led to implementable solutions to strategic problems, increased communication between stakeholders at all levels and has had a positive effect on morale and job satisfaction.

It is recommended that a similar model could be adopted within UK fingerprinting, at a regional or national level, to increase communication between laboratories, bureaux, and external stakeholders. It may be that the Forensic Science Special Interest Group could facilitate the initiation of such a model.

6.3 Examples of Key Issues for Future Innovation

Examples of some ongoing areas of operational fingerprint research are provided within this section. These are aspects of operational fingermark development and fingerprint comparison within which it has been recognised that there is the need for further work.

6.3.1 Cognitive Issues in the Fingerprint Domain

Psychological research has found that nearly, if not, all human observational measurements are prone to cognitive bias. These effects can take many different forms and influence people in a variety of ways. For example, confirmation bias is when people notice and give more weight to information that is consistent with and supports certain interpretations and not others. Escalation of commitment and momentum, conformity, need for closure, prophecies that fulfil themselves are just a few other psychological and cognitive phenomena where experts unavoidably and unconsciously lose objectivity and can be selective and biased in their analysis.

Cognitive bias was first associated with fingerprint evidence during the Brandon Mayfield case when the term 'confirmation bias' was used to explain the cascading of the misattribution through the series of checks (verification, second verification, and independent review), designed to detect errors. This represented an implicit concession that fingerprint evidence is prone to biasing effects.

In the past the issue of 'cognitive contamination' was largely misunderstood by the fingerprint profession, however, the forensic and fingerprinting domains are now beginning to take note of the risks associated with cognitive contamination and changes to processes and procedures are being evaluated.

Some practitioners in the fingerprint domain have understood the need to consider the human examiner and their skills and motivations as an important factor in serving more effective forensic science, and there have been a number of studies carried out within fingerprinting in the UK and abroad that look to better understand the decision-making of fingerprint examiners and practitioners. Some police forces have employed the services of cognitive consultants to deliver bias awareness training to practitioners. Equally, there is a growing body of research that looks at methods of utilising probabilities to enable fingerprint examiners to provide a more objective justification of their decision-making to the court. This approach is advantageous as it moves away from the requirement of an examiner to state a match with absolute certainty, and has the potential to acknowledge the errors, biases and uncertainties inherent in the subjective decision of a fingerprint identification.

Fingerprint examiners are widely considered to be reliable expert witnesses, trusted by juries, and their evidence, therefore, carries considerable weight in the courtroom. The consideration of human factors within fingerprinting is essential to enable examiners to give transparent and reliable fingerprint testimony that does not mislead the court. Fiscal constraints and the need for radical changes to working practices and processes require, more than ever, that the practitioner and the mind is understood so that required changes in order to implement new technology and/or new processes, such as reducing the number of verification checks required during the ACE-V process, or lights out processing (whereby processes are carried out without any human intervention), can be validated scientifically before their introduction.

Further research is required, on the one hand, to provide methodologies that minimise or control bias, and, on the other hand, to provide mechanisms for the reporting of fingerprint evidence that take cognitive factors into account and are readily understood by a lay jury.

6.3.2 Remote Transmission

A number of UK police forces are beginning to use remote transmission technology to transfer fingermark images from crime scenes and Fingerprint Enhancement Laboratories to the Fingerprint Bureau. Transferring fingermark evidence in this way increases the speed at which the evidence can be processed and also removes the need for physical transportation by a member of staff. Ultimately this can

lead to a 'paperless Bureau', reducing the requirements for physical storage of fingermarks and the costs associated with the storage and maintenance of fingermark collections.

Case Study 4 described the setup of the current project being undertaken to implement the Forensic Identification Bureau Remote Evidence System (FIBRE system) for remote transmission in Surrey and Sussex Police Fingerprint Bureau. The FIBRE software has been designed with an ISO framework, transparent working and the ability to defend actions, in mind. The new software will allow examiners to carry out more comprehensive annotations of fingermarks, more thoroughly documenting their decision-making process, and will enable management to pick up on questionable decision-making, for example annotating points in the wrong order to corroborate with a crime scene print. In this way, the software can help to tackle circular reasoning. There also maybe potential to use FIBRE as a triage tool using an algorithm produced by Pattern Analytics which analyses the prints when they are inputted and automatically brings up 'hits', removing the need for a human examiner at this stage. If the fingermark is of good enough quality, then this could quicken the process from scanned print to comparison. FIBRE may also be able to use a similar algorithm to code patterns and, potentially in the future, to search against a database.

There has traditionally been a lack of consistency in the case management and other software used by police forces across the UK, and a tendency for police forces to work in isolation when introducing new software and systems. It has been claimed that police forces often implement new software before fully screening its suitability and compatibility with current systems and procedures, resulting in resources wasted on systems that are not fit for purpose and so are not fully utilised. Therefore, it is crucial that the procurement of remote transmission software is carefully managed and that knowledge and experience is shared across forces to ensure a consistent, best practice approach across the board. Surrey and Sussex are an example of a force that are attempting to combat these issues through working alongside a software developer to ensure that the end product is fit for purpose by playing an active role in the design and trialling of the FIBRE system. Equally, the Force is keen to share its own experiences of the project and to improve knowledge transfer of remote transmission through setting up a FIBRE national group to share information, standards and experiences.

However, FIBRE is not the only such system on the market and so discussions between users of all systems and the sharing of the experiences of all stakeholders would seem vital in this area. It is an ideal opportunity to increase consistency between the technologies used by police forces across the UK, and learn from the experiences of other Forces. Increased consistency in systems ensures that policing can occur at a national level when required and that there are not barriers to the remote transmission of evidence from Force to Force in these cases. Equally this ensures that validation of a Force's system can be more easily achieved.

6.3.3 Future Research Needs within Fingermark Development

Advances continue to be made in the number and effectiveness of fingermark development processes available to the practitioner. Work continues for a variety of reasons, including to address current capability gaps, to increase the effectiveness of existing processes, or to reduce the time and/or cost of fingermark enhancement. Examples of recent developments in processing techniques include:

- Acid Yellow 7 – addressing the need for a fluorescent blood dye for use on dark, non-porous surfaces
- Multi-metal deposition – addressing a need for a process for developing fingermarks on Clingfilm
- Natural Yellow 3 – addressing the need for a fluorescent fat stain for use on dark, non-porous surfaces
- Powder suspensions – increasing fingermark recovery rates on wetted non-porous surfaces

There are still challenges that remain, for example processes capable of increasing recovery rates on leather and certain types of metal surface are desirable. There is increasing emphasis on treating more items and surfaces at the crime scene rather than the laboratory, and to support this, non-toxic, non-flammable chemical processes that are capable of rapidly developing marks are required to support light source examination. In the laboratory, the most effective processes are not always used because they

are more resource (time and/or cost) intensive. The research and development of equipment that could overcome some of these barriers to implementation could also be a fruitful area of study. Some examples of areas where further research and development effort could yield operational benefits include:

- Processes with increased effectiveness for 'low yield' substrates, e.g. leather, fabrics, matt painted walls, lead, untreated wood
- Adaptation of laboratory-based processes for use at crime scenes, e.g. reducing the mess associated with application of powder suspensions; and identifying non-flammable, non-ozone depleting chemical reagents with rapid development times
- Development of equipment to increase usage/throughput of highly effective but time consuming processes, e.g. adapted flatbed scanners for imaging fluorescent marks on paper, 'dish washer' cabinets for automated bulk application of powder suspensions

6.4 Funding for Fingerprinting Research

Funding for research within the fingerprinting domain has typically been significantly lower than that for other identification sciences such as DNA. This is partly because it has been considered as a more mature, fully understood science, and also because the equipment and facilities for fingermark enhancement tend to be lower in complexity and cost. An overview of some of the ways in which fingerprint research has been funded is given below.

Some research into fingerprints was directly funded by the Forensic Science Service (FSS). Latterly, such research was directed towards areas that could provide commercial benefits to the FSS, including work into 'test sheets' of simulated fingermark constituents to be used to test whether processes were working effectively; funding of research into novel enhancement processes that could give the FSS a unique capability; and development of a software tool for producing probabilistic assessments of the evidential value of partial fingermarks. This line of research funding had been reducing and ultimately ceased when the FSS was wound down. None of the commercial forensic service providers currently offer a major capability in fingermark enhancement and do not, therefore, fund research in this area. This is also the case for Police Forces who similarly have no funding to drive such initiatives.

The Centre for Applied Science and Technology (CAST) and its precursor organisations have maintained a fingerprint research programme in some form for over 40 years. This has occasionally (e.g. early to mid 1970s) involved significant external funding of fundamental research at universities and other research institutes, and at other times (e.g. early to mid 1980s) involved external funding of industry to produce equipment based on prototypes developed at CAST. Currently, CAST provide a limited amount of research funding in the form of part-funded PhDs, some to address fundamental issues of fingermark enhancement and others to address issues related to Home Office policy priorities. In addition to this, CAST also act in a coordinating role by providing research ideas to universities for both BSc and MSc students and assisting in project supervision. CAST does not generally fund this and projects of this type are mostly evolutionary in nature as opposed to revolutionary, or are designed to fill gaps in existing knowledge.

The Engineering and Physical Sciences Research Council (EPSRC) have also occasionally funded research into fingermark enhancement, although much of this has been through previous targeted calls for proposals related to crime. Some of the more novel, revolutionary processes may emerge from this route because calls of this type encourage researchers in other scientific disciplines that may have observed developed fingermarks, by a 'happy accident', and recognise the novelty and potential of their work and seek to develop it further. However, EPSRC has not issued a focused call of this type for several years. Although EPSRC is open to forensic-related proposals outside a focused call, very few have been funded because they are either too applied, lack novelty, or submissions have been considered low in quality.

The Defence Science and Technology Laboratory (DSTL) have also funded short-term pieces of forensic-related research via their Centre for Defence Enterprise (CDE) calls. This tends to focus on technologies that have already been shown to be feasible and need additional funding to progress to the stage of a technology demonstrator. Some fingerprint related research has been funded through this route, but

this funding route is anticipated to reduce as overseas military engagements wind down.

More recently the European Economic Community (EEC) have awarded a research grant of €3 million to the University of Leicester to carry out research on a variety of topics associated with fingerprinting. These range from chemistry to cognitive bias, and from technology to criminology.

7. Conclusion and Summary of Recommendations

This report has aimed to provide the reader with the necessary background information to gain a familiarity with the processes, stakeholders, and interactions within the UK fingerprinting community. The hope is that this background information will be of interest to those external to the fingerprint domain and will provide a starting point for innovation, knowledge transfer, and collaborative working towards innovation within the field. The report is not aimed specifically at fingerprint examiners or other forensic experts and researchers.

The recommendations made within this report are summarised here as follows:

Recommendation 1: Increased dissemination of research and development within UK fingerprinting that is accessible to all stakeholders.

Recommendation 2: A forum for communication for Fingerprint Enhancement Laboratories at a national level with a representative attending the Fingerprint Quality Standards Specialist Group.

Recommendation 3: Open and collaborative relationships between Police Force Laboratories and Bureaux and increased two-way communication between them.

Recommendation 4: The implementation of a model of innovation and creativity within the investigative process involving all types and levels of stakeholder within UK fingerprinting.

It is hoped that the recommendations made within this report in relation to operational fingerprinting will have an impact upon the fingerprint community. This may be through starting debate and discussion, through the uptake of the recommendations by the community itself, or through the facilitation of the uptake of recommendations by the Forensic Science Special Interest Group and other interested parties.

8. Authorship and Acknowledgements

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Helen Earwaker is a researcher with a background in operational fingermark development. She has a BSc and MSc in forensic science. Helen worked for three years as a fingerprint recovery officer for Northumbria Police and is currently completing a PhD within the Doctoral Training Centre of Department of Security and Crime Science at University College London, in conjunction with the Centre for Forensic Sciences. Her research focus is decision-making within Fingerprint Enhancement Laboratories, and she is involved in research collaborations with a number of fingerprint stakeholders across the UK.

Co-author: Dr David Charlton

Dave Charlton is a forensic practitioner and manager who has worked in the domain of crime scene and fingerprint examination for nearly 30 years. He has a PhD in Forensic Science and he investigated the links between the accuracy of forensic decision-making and the influence of bias through cognitive contamination (context). In completing this research he was awarded the British Psychological Society, Forensic Division junior prize for outstanding research in a forensic domain. Dr Charlton continues to work operationally, but also advises expert groups domestically and internationally on best practice within the sphere of fingerprint examination.

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Steve Bleay has a BSc and PhD in Materials Science from the University of Bath. After 10 years researching stealth materials at the Defence Research Agency/QinetiQ, he joined the Home Office in 2003 to conduct research into fingermark enhancement and imaging. His work has included research into vacuum metal deposition, recovery of fingermarks from arson scenes and remote transmission of crime scene marks. He has built extensive research networks with academia, resulting in contributions to over 30 peer reviewed journal publications. He also provided expert assistance in fingermark development and imaging to the Scottish Fingerprint Inquiry. Steve is one of the principal authors of the Fingermark Visualisation Manual.

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9. Glossary of Domain Specific Terms

A glossary of key domain specific terms and acronyms is provided to aid in the understanding of this document and to provide background information in relation to the fingerprinting domain.

ACE-V: The process of Analysis, Comparison, Evaluation and Verification undertaken by Fingerprint Examiners when looking to compare a crime scene fingermark with an exemplar fingerprint.

Acid Black 1: (Also related dyes Acid Yellow 7 and Acid Violet 17). A series of chemicals used to develop fingermarks deposited in blood. The most appropriate of these chemicals is selected to give the best contrast with the surface that the mark is on. Acid Yellow 7 is also fluorescent.

AFIS: Automated Fingerprint Identification System utilised by UK Police Force Fingerprint Bureaux. A fingermark is inputted into the AFIS system, which returns the most similar fingermarks from its database. The AFIS system does not provide an entirely automated fingerprint identification; examiners need to follow the ACE-V process to compare any similar prints suggested from within the database to the crime scene fingermark.

BY40 (Basic Yellow 40): Type of fluorescent dye commonly used to stain fingermarks that have been developed using cyanoacrylate (superglue). The dye is applied to the chemically treated item and then the excess is removed leaving only that which had adhered to the developed fingermarks. The dye fluoresces under blue/violet light producing a green fluorescence, improving the contrast of developed fingermarks when viewed using an appropriate light source and viewing filters.

Continuity: Items of forensic evidence must be continually accounted for. Each time the evidence is examined, transported or stored this must be documented. Exhibits received for fingerprint development must be recorded as must all techniques carried out. The movement of lifted fingerprints must also be accounted for in the same way.

Cyanoacrylate: Also known as superglue fuming. A chemical process used to develop latent fingermarks on non-porous items. Cyanoacrylate is vaporised in a chamber with the exhibits to be treated, polymerisation of the vapour occurs on the latent fingermark, initiated by water, salts and certain other constituents and making the ridges visible. The exhibit is often then stained with BY40 dye (see above).

DFO: A fluorescent chemical used to develop latent fingermarks of porous surfaces. The fluorescent nature of the technique makes it suitable for use when there would be poor contrast between the surface of the exhibit and a fingermark developed with ninhydrin. Often DFO is used as part of a sequence of techniques to develop fingermarks on porous surfaces. It is more sensitive than ninhydrin but less widely used because it requires fluorescence examination to visualise developed marks.

Elimination prints: A set of fingerprints taken, either electronically or with ink and paper, from a person who may be legitimately involved in a case and so may have left their fingermarks on items of evidence or at a crime scene. Any fingermarks recovered from the crime scene can then be eliminated if they are found to be a match to the elimination prints.

Exhibits: Items of evidence in a case that have been recovered. These will be given a unique evidence reference number and may be presented in court. In Scotland an exhibit is called a production.

Fingermark: A fingermark is the term used to describe a latent or crime scene deposit of secretions from the sweat pores, which is often invisible prior to development or visualisation techniques.

Fingermark constituents: The chemicals that comprise the secretion from the sweat pores that is deposited as a latent fingermark. The chemical constituents of a fingermark include aqueous deposits, fatty acids and amino acids.

Fingerprint: A fingerprint (as opposed to fingermark) is used to describe the inked or scanned impression of the friction ridge skin of a finger on a surface, for example a set of elimination fingerprints.

Fingerprint Brush: A fingerprint brush used to apply fingerprint powders to latent prints. The type of brush being used depends upon the type of powder being applied and the surface being examined. Types of fingerprint brush include the magnetic brushes to apply magnetic fingerprint powder, synthetic

or glass fibre ‘Zephyr’ style brushes and natural squirrel-hair brushes.

Fingerprint lift: A technique used to preserve a fingermark developed using fingerprint powders. A piece of adhesive tape is placed over the powdered fingermark and pressed on to its surface. The tape is then gently peeled away taking the mark with it and secured on a clear acetate sheet. This ensures that the lifted fingermark cannot be damaged, distorted or tampered with.

Fingerprint powder: Used to physically develop or visualise a latent fingermark, fingerprint powders are brushed onto the surface of a smooth non-porous item, such a plastic, glass or metal. The particles of the powder adhere to the aqueous and sebaceous constituents of the fingermark residue. A number of different powders are available and a powder is selected according to the texture of the surface type to be treated and according to which powder will provide the greatest contrast with the background surface. A number of fingerprint powders are fluorescent which can increase contrast.

Friction ridge skin: The skin of the hands and feet containing ridges that are formed during foetal development. The mechanism of the development of friction ridge skin causes it to be unique and permanent, resulting in the uniqueness and permanence of fingerprints.

Identification: A match between a crime scene fingermark and a fingerprint taken from a person of interest.

Integrity: Refers to the integrity of exhibits within a case. It is essential that all exhibits must be securely packaged and that any time the exhibit is removed from it’s packaging this is documented. In the case of fingerprint lifts, integrity is ensured by signing across the surface of the tape used to secure the lift so that it would be apparent if this lift has been tampered with.

Laser: See light source examination. A laser is a high intensity light source fixed at one wavelength. Lasers are often used during initial light source examinations to visualise fingermarks without the need for prior enhancement.

Latent: Invisible fingermark deposited at a crime scene.

Light source examination: Examination carried out within a fingerprint development laboratory or at a crime scene. A high intensity light source is utilised to observe latent or chemically developed fingermarks. A light source examination is a non-destructive initial process often undertaken within a fingerprint laboratory to visualise latent fingermarks prior to the use of chemical development techniques. A number of different light sources are available. These include lasers with outputs at a variety of wavelengths, filtered high intensity white light sources such as quasers that can be set at a variety of wave bands, and LEDs which are generally hand-held ‘torch’ light sources with a range of different output wave bands (colours).

Live scan: A device used to capture fingerprints from persons of interest in a case. Ten-prints generated through capture with live scan can be electronically transmitted to a fingerprint bureau.

Marking-up: The process carried out within fingermark enhancement laboratories by which laboratory practitioners select and highlight the pieces of fingermark detail that they believe are of sufficient quality to submit to the fingerprint bureau.

Ninhydrin: A chemical commonly used to develop latent fingermarks. This technique is primarily used within a fingermark enhancement laboratory but can also be used in situ at a crime scene. Ninhydrin is a type of protein stain which reacts with the amino acids present in a fingermark deposit, causing a colour change in the pattern of the ridge detail present, generally turning them purple.

No value: A fingermark deemed by a fingerprint examiner to be of no value for identification or exclusion.

Patent fingermark: A visible fingermark. This may be a fingermark made in a contaminant such as blood or latent, or may be the impression of a fingermark left in a substance such putty.

Person of interest: A person who is of interest in a case from the point of view of fingerprint comparison; the ten-prints of a person of interest will be compared against the crime scene fingermark.

Quaser: A name for one type of high intensity white light forensic light source, which can be set to a

number of different wavebands. A quaser is used to carry out initial light source examinations prior to chemical treatment to develop fingermarks and is also used after chemical development has taken place to visualise fluorescent dyes such as BY40, which enhance the contrast between a developed fingermark and the background surface of the exhibit.

Ridge detail: Term used to describe the lines of a developed fingermark. A certain amount or quality of ridge detail will need to be present to make the fingermark suitable for analysis by a fingerprint examiner.

Streamlined Forensic Reporting: A recently introduced system which has been designed to enable prosecutors and scientists to better adhere to the Criminal Procedure Rules through allowing a quicker processing of key items of forensic evidence. The prosecution may now present the key items of forensic evidence to the defence without having to have carried out analysis of all items in the case. This means that it may be possible that a guilty plea will be given based on key items of evidence, without having to use up resources processing all evidence up to this point.

Ten-print card: A set of inked or scanned impression of each finger for elimination purposes or checking a person of interest. A ten-print card will also include palm prints.

Wet powder suspensions: A solution of powder suspended in a liquid carrier that is applied to a non-porous surface to develop latent fingermarks. The powder within the suspension will adhere to certain constituents within the fingermark (thought to be eccrine constituents trapped within water-insoluble components), leaving the background clear of powder once the exhibit has been rinsed.

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11. Appendix

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Appendix 1: Common Fingerprint Development Techniques

A number of fingerprint development techniques are utilised within a Fingerprint Enhancement Laboratory. It is recommended that prior to carrying out physical or chemical fingermark development techniques an examination is first carried out with white light and a variety of forensic light sources. A comprehensive guide to fingerprint examination is provided in The Home Office Centre for the Applied Sciences Fingermark Visualisation Manual (discussed further in Case Study 3, Chapter 4.4). An example of a number of frequently used fingermark development methods is provided in the table below.

Technique / Chemical Process	Surface used on:	Reacts with:	Comments
Powders	Non porous shiny e.g. paper/card/glass metal	Physical process; adheres to aqueous and sebaceous components of fingermark	A number of different fingerprint powders are available. Powders are selected to provide the best contrast with the surface in question and/or be most suitable for the surface texture of the item
Ninhydrin	Porous surfaces e.g. paper, cardboard, untreated wood	Chemical process; reacts with amino acid components of fingermark	Produces a purple colour change along the fingermark ridges
DFO	Porous surfaces e.g. paper, cardboard, untreated wood	Chemical process; reacts with amino acid fingermark components	Similar reaction to ninhydrin but produces a fluorescent product. More sensitive than ninhydrin and useful in cases where ninhydrin developed fingermarks would have poor contrast. Can be used sequentially before ninhydrin
Cyanoacrylate	Smooth, non-porous surfaces e.g. plastic, glass	Chemical process: reacts with aqueous constituents	Also known as Superglue fuming. White deposits (actually fine polymer fibres) are formed by the process on the fingermark ridges. These are often dyed with a fluorescent dye in order to improve contrast with the exhibit surface
Wet powder suspension	Smooth, non-porous surfaces, some semi porous surfaces	Exact mechanism unknown but thought to adhere to eccrine constituents in a water insoluble matrix	Could have more crime scene applications if mess associated with usage could be reduced
Acid black 1, acid violet 17, & acid yellow 7	Non-porous surfaces contaminated with blood	Blood (proteins)	Acid yellow is fluorescent. The Acid chemicals can be used sequentially to increase their effectiveness

Appendix 2: The Process of Fingerprint Comparison: ACE-V

When comparing detail between a crime scene mark and a ten-print exemplar obtained from a suspect under controlled conditions, a generic methodology has been adopted in most countries in the World known as ACE-V. The examiner first Assess the friction ridge detail in the crime scene mark so that useful reference points can be identified in the next phase. Next, there must be a Comparison of the mark features with that of features within the reference print. Then there must be an Evaluation of the findings, from which conclusions as to whether there are relative consistencies that would suggest the crime scene mark and exemplar were from the same source must be derived. Finally, there must be an element of peer review, known as Verification, to repeat the ACE process independently, helping to remove contextual bias and to cross validate earlier findings.

During an Assessment, the fingerprint examiner will assess the crime scene fingermark for: any distortion present, its orientation, the development and visualisation methods and medium used, the deposition pressure of the fingermark, the anatomical attributes (features), and the clarity of the fingermark.

During the Comparison, the examiner will look for similarities between the crime scene and exemplar print, in: pattern, ridge path, ridge shape, and pore positioning.

During the Evaluation, the examiner will look to form an opinion as to: whether the crime scene fingermark can be eliminated as being from the same source as the exemplar print, and whether there is sufficient consistency of information available between the two fingermarks to conclude that they originated from the same source.

During Verification, an independent assessment of the casework is undertaken to see whether the ACE process has been correctly carried out and that the conclusions reached are consistent with the original findings. In the UK, for a crime scene mark to be identified, the comparison must be undertaken three times. The original examiner will make an initial check, with verification by two further experts who must come to the same conclusions independently. It should be noted that the number of confirmatory checks that take place is not based upon scientific research at this time and there is on-going discussion as to whether the number of checks in the process should be reduced.

Appendix 3: Forensic Training at the College of Policing

Fingerprint related forensic training for police staff is either provided in house by dedicated training, or is provided by the College of Policing. As such the College of Policing is the sole external provider of training in this domain to operational policing. The majority of UK forces take advantage of the training courses on offer as doing so means that trainees are able to learn at the state of the art Forensic Centre at Harperley Hall in Durham, as opposed to within an operational setting which may interfere with case-work. This is particularly important as it is typically small numbers of new recruits from one force that require training at a time, and this would otherwise necessitate costly one on one training. The College of Policing also supplies training to a number of organisations from the UK and abroad who are not part of the UK Home Office police forces. Forensic training that includes fingerprinting is offered under a number of vocationally driven courses:

Crime Scene Investigation

The Foundation Crime Scene Investigators Learning Programme is designed for newly recruited Scenes of Crime Officers or those carrying out crime scene investigation as part of their role including fingerprint examinations at crime scenes. The course is divided into two stages, both of which consist of pre course learning, a residential course at the Forensic Centre and a Professional Development Portfolio.

Fingerprint Laboratory Officer Learning Programme (FLO)

The Fingerprint Laboratory Officer Learning Programme is designed for training newly appointed fingerprint development laboratory staff. This training programme has two aspects, an initial foundations skills course and a subsequent crime scene skills course. The foundation skills is intended to provide the initial training required for the laboratory officer to carry out their role of developing and recording fingermarks within the laboratory through appropriate selection and application of chemical techniques and subsequent use of imaging to record developed fingermarks. This course has three distinct elements; a course pre-requirement is the completion of a training workbook, the two week taught practical course is then attended, and, back in force, the student must complete a further training Professional Development Portfolio once back in force. The crime scenes skills course provides further training into the application of these skills at a crime scene. This course is intended for practitioners who are experienced in carrying out development techniques within the laboratory.

National Fingerprint Learning Programme

The National Fingerprint Learning Programme is an ACPO approved programme, which covers the progression of fingerprint examiners from foundation to advanced level over three to four years. The programme consists of four courses, fingerprint foundation for newly recruited examiners, fingerprint intermediate, advanced fingerprint assessment and ten-print operator.

In addition to these core courses the College of Policing also offers a range of Continuous Professional Development Workshops for fingerprint examiners who have completed their initial learning programme and have achieved expert status. CPD workshops are offered in court skills, identification skills, AFIS skills, forensic awareness, palms, and assessor training.

Appendix 4: The CAST Fingermark Visualisation Manual

The new Fingermark Visualisation Manual is an electronic, interactive document (currently an interactive PDF file, but to be migrated to HTML format in future). It places emphasis on building practitioner competence and encouraging communication between the practitioners involved in different stages of the evidence recovery process. The Manual has been significantly expanded from the previous edition (issued in 1998) to include information that will build the background knowledge of practitioners, encouraging them to gather information and use this in conjunction with their competence as part of a decision making process.

The Manual is divided into seven chapters with two appendices and a glossary. Chapter 1 is relatively short and provides an introduction and a user guide to the Manual. Chapter 2 is more substantial and provides a significant amount of background information. It is designed to be used as the basis of training courses for those working with fingermarks. The chapter includes an understanding of the role of fingermark recovery in the broader context of crime investigation, the ways in which fingermarks are formed, the composition of fingermark deposits, the influence of the surface and environment on fingermarks post-deposition, an overview of the processes that can be used to visualise fingermarks, how these processes utilise different properties of the mark, and how they can be used in sequence. Examples are given that illustrate the need for communication between those visualising and imaging marks and those involved in their comparison and identification.

Chapter 3 describes requirements for working safely and effectively in laboratories and to a lesser extent at crime scenes. This includes descriptions of the facilities required to carry out the processes, practical advice on working in laboratories and making solutions, handling and packaging of items and an awareness of both physical and chemical hazards. The chapter also covers good practice when capturing images of visualised marks.

Chapter 4 contains sequential processing charts for a wide range of different substrates, starting with generic charts for porous, semi-porous and non-porous surfaces and showing how these can be refined when more information about the surface, environment or contaminants in the fingermark is available.

Chapter 5 provides information for the range of visualisation processes that are recommended for routine use, including formulations, health and safety information, process instructions and disposal and storage post-processing. An illustrated 'Troubleshooting' guide is also given where it is appropriate to the process. Information is also given regarding considerations for use of each process at crime scenes.

Chapter 6 also provides process information, but in this case on the wider range of processes that are not currently recommended for routine use. These are divided into those with niche applications and/or emerging technologies, processes only recommended for remedial actions, those with no known operational benefits, and those with health and safety issues associated with them.

The last chapter, Chapter 7, promotes the philosophy of integrated forensic recovery. It gives a basic overview of the other principal classes of forensic evidence (including DNA) and describes how these evidence types may be affected by fingermark processes, and how fingermarks may be adversely affected by recovery of other forms of forensic evidence. Communication between practitioners from different disciplines is encouraged so that evidence recovery can be properly prioritised and maximised.

The appendices provide case studies showing how the decision making process can be applied to different operational scenarios, and also an outline framework for research and validation of fingermark enhancement processes.

The Manual was implemented by means of a series of practitioner workshops held in conjunction with the College of Policing, explaining the changes in content and presentation to users and using practical exercises to build familiarity with where to find information and how to use it. The CAST team have also presented on the Manual at a series of national and international conferences (Fingerprint Society, International Association of Identification (IAI), Australian and New Zealand Forensic Science Society(ANZFSS) to reach as wide an audience as possible.

The Fingermark Visualisation Manual is provided free of charge to UK police forces and law enforcement

agencies but will also be available to international users, industry and academia, although at a charge. The distribution and sales of the Manual (which can be purchased) will be conducted by the Stationery Office.

Appendix 5: Examples of Current Fingerprint Research and Development

Organisation	Researcher	Research Interests	Comments
University of Abertay, Dundee	Dr Kevin Farrugia	Chemical latent mark enhancement (including footwear mark enhancement on cloth, blood mark enhancement, mark enhancement of foodstuffs).	Part of the University of Abertay Forensic Science Research Group
University of Abertay, Dundee	Dr Graham Wightman	Material behaviour in a forensic context. Research includes behaviour and chemical enhancement of finger-marks on metals and the development of an etching paste to recover erased marks.	Part of the University of Abertay Forensic Science Research Group
University of Abertay, Dundee	Joanna Fraser	The recovery of fingerprints on fabric using Vacuum Metal Deposition and Superglue fuming techniques.	Part of University of Abertay Forensic Science Research Group. Has carried out collaborative work with SPSA and Home Office CAST
University of Abertay, Dundee	Dennis Gordon	The acquisition of fingerprints from foodstuffs, and eggs and feathers of birds of prey.	Part of the University of Abertay Forensic Science Research Group
Anglia Ruskin University	Jo Dawkins	Finger-mark development.	Part of Anglia Ruskin Forensic Science and Chemistry Research Group. Jo used to be a CSI
Brunel University	Dr Nicole AttardMontalto	Surface interactions between finger-marks and materials. Determining the order of deposition of inks and finger-marks.	
Centre for Applied Science and Technology (Home Office CAST)	CAST Dr Steve Bleay Vaughn Sears Rory Downham Dr Helen Bandey	A range of research into the chemical development and capture of latent finger-marks. This research tends to involve assessing the performance of novel chemical finger-mark development techniques or sequences of novel chemical development techniques. Coordination of informal fingerprint research network via meetings at Home Office, allocation of finger-mark research projects to interested universities as undergraduate and masters projects.	CAST research underpins the recommendations that are made in the Fingerprint Development Manual
Cognitive Consultants International	Dr Itiel Dror & Dr Peter Fraser-Mackenzie	Cognitive factors in fingerprint evidence interpretation.	Dr Itiel Dror is an Associate Senior Lecturer at University College London
University of Derby	Adam Long	Finger-mark detection and enhancement techniques and factors affecting mark persistence, enhancement and recovery.	
University of East Anglia	Prof David Russell	Functionalization of gold nanoparticles and iron oxide macro particles with antibodies for the detection of drugs and/or drug metabolites within latent fingerprints.	

Organisation	Researcher	Research Interests	Comments
European Network of Forensic Science Institutes(ENFSI)	European Fingerprint Working Group	Research is undertaken by the European Fingerprint Working Group (with UK input) either as an overall working group or according to division into finger-mark detection, or finger-mark identification specific working groups.	Research carried out by ENFSI is not currently routinely disseminated outside of the network.
Fingerprint Quality Standards Specialist Group	Members of the Fingerprint Quality Standards Specialist Group	A number of research projects including interest in fingerprint evidence interpretation and proficiency testing.	
Forensic Focus	Dr Karen Stow and Luke McGarr	Current collaborative research projects include determining aging factors in finger-marks, and tracing medieval wax seals to UK cathedrals through fingerprint identification.	Collaborators are Madrid Police, and Lincoln and Aberystwyth Universities, respectively.
Gardiner Associates	Jack Deans	The recovery of finger-marks from fire scenes.	Collaborators are Thames Valley Police fingerprint enhancement laboratory.
University of Leicester	Dr John Bond	Visualisation of corroded fingerprints on metal surfaces (e.g. cartridge cases) through the development and application of technology that exploits changes in the electrical and optical properties of the metal that has come into contact with fingerprint residues. The development of thermal technology to develop finger-marks on thermal papers (receipts).	Products for both purposes have been manufactured by Consolite Forensics (see Industry Stakeholders).
University of Leicester	Dr Julie Pratt	The development of a sensitive technique for developing low quality finger-marks on metal surfaces using electro polymerisation of a monomer onto a conducting surface.	
University of Leicester	Dr Lisa Smith	Decision-making; interpretation of fingerprint evidence in the Criminal Justice System (e.g. police investigations, courtroom); improving the recovery and interpretation and processing of fingerprint evidence by police agencies.	
University of Leicester	Prof Jeremy Levesley	Use of mathematical modelling to determine fingerprint complexity to aid training and quality assurance.	
University of Leicester	Prof Rob Hillman	Electrochemistry. Novel chemistries for revealing finger-marks on different types of metal surface.	
Loughborough University	Dr Paul Kelly	Inorganic chemistry. Novel chemistries for enhancement of latent finger-marks (e.g. disulphuricdinitride), enhancement techniques for metal contaminants within finger-marks (e.g. gunshot residues, metal theft).	
Metropolitan Police	Lisa Hall	Methods of validation, competency and proficiency testing within the Metropolitan Police as a means of internal quality assurance.	Works collaboratively with UK academia including Kings College London and UCL. Lisa is a fingerprint examiner.

Organisation	Researcher	Research Interests	Comments
Netherlands Forensic Institute	Dr Marcel de Puit	The development and chemical profiling of fingerprints. Using fingerprints for the evaluation of hypotheses at activity level.	Working with University of Leeds.
Scottish Police Authority (SPA)	Kenny Laing	The novel use of wet powder suspensions and the use of liquid nitrogen for application to finger-mark development.	
Sheffield Hallam University	Robert Bradshaw	Integration of MALDI MSI into the current Home Office forensic finger-mark examination workflow	Collaborative research with CAST
Staffordshire University	Dr Sarah Fieldhouse	Research interests include consistency in finger-mark deposition for research purposes, fingerprint researcher competency and proficiency testing. Current research includes: The design of fingerprint research projects (including mark deposition and the assessment of finger-mark quality) Finger-mark development using CNA fuming in situ Determining the sequence of latent finger-marks and ink/printing on suspect documents	Sarah has collaborated with SciChem (see Industry stakeholders) who have manufactured 'fingerprint samplers' to facilitate finger-mark deposition for research purposes. Sarah has worked collaboratively with CAST on researcher competency research.
Staffordshire University	Dr Sandra Von Paris	The Bayesian evaluation of fingerprint evidence using automatic biometric systems.	
University of Strathclyde	Prof Niamh NicDaeid* (Prof Nic Daeid has now moved her research group to Dundee University)	The statistical and Bayesian evaluation of evidence. Recovery of finger-marks from firearms and ammunition.	Current research includes a collaborative project with Joanne Tierney from SPA looking at establishing a ground truth data set of finger-marks for quality assurance purposes.
University of Strathclyde	Prof James Fraser	Fingerprint evidence interpretation.	Has produced and implemented the 'fingerprints – a road map to reform' workshop as part of his role as Scientific Advisor to the Fingerprint Quality Standards Specialist Group.
Surrey and Sussex Police	Dr David Charlton	Methods of validation, competency and proficiency testing with Surrey and Sussex Police as a means of internals quality assurance. Also collaborates with a wide range of academics in the sphere of criminology and psychology and is looking at how technology can help support determination of fingerprint complexity and provide training and recruitment tools for the profession.	Works collaboratively with UK academia including Bournemouth University, the University of Leicester and The Sir Alec Jeffries Institute. In addition, Dave also works with CCI as a consultant with Dr Itiel Dror. Dave is a fingerprint examiner.

Organisation	Researcher	Research Interests	Comments
University of Surrey	Dr Melanie Bailey	Forensic chemistry, ion beam analysis. Use of secondary ion mass spectrometry for revealing additional detail in finger-marks, for detection of contaminants in finger-marks, and for revealing contextual information (e.g. order of mark/ink deposition).	Works collaboratively with Netherlands Forensic Institute.
Sussex University	Professor Robert Prance	Electrostatics. Detection of fingerprints by use of a scanning electrostatic probe.	
Swansea University	Dr Geraint Williams	Corrosion engineering. Use of the scanning Kelvin probe as a means of detecting finger-marks on metal surfaces.	
Teesside University	Dr Mark Butler	The effects of expertise on crime scene processing by scenes of crime officers (including fingerprint recovery) and the use of eye tracking technology to document decision-making and prioritisation at crime scenes.	Formerly a CSI and a CSI trainer at the College of Policing.
Teesside University	Tim James	Latent finger-mark persistence and development techniques.	Formerly a CSI.
Teesside University	Samuel Cadd	Chemical composition of finger-marks.	
Teesside University	Kyp Georgiou	Fingerprint recovery from recycled plastics.	
University College London (UCL)	Helen Earwaker	Finger-mark sufficiency decision-making within fingerprint enhancement laboratories.	Formerly a finger-mark development practitioner.
West Technology Systems	Eleigh Brewer	The use of vacuum metal deposition to develop finger-marks on fabrics and polymer bank notes, with subsequent DNA recovery.	Collaborative research with University of the West of England
University of Westminster	John Smith	Imaging of fingerprints. The optimisation of fingerprint recovery on human skin.	Formerly employed by LGC. Research undertaken through EU ISEC programme.
University of Wolverhampton	Dr Raul Sutton	The use of automated methods for analysing palmar marks and the effect of rotation, displacement and degradation on identification using palmar flexion creases.	

Appendix 6: Past and Ongoing Output of the Fingerprint Quality Standards Specialist Group

Past Output of the Quality Standards Working Group: Fingerprints – a road map for reform

A series of workshops entitled 'Fingerprints – a road map for reform' were designed and carried out in a collaborative venture between Strathclyde University and the University of Dundee. The workshops aimed to provide a starting point for major reform in fingerprint examination in light of high profile errors from within the fingerprint community such as those exposed during the Scottish Fingerprint Inquiry.

A series of three workshops were run. The first targeted senior representatives from a number of organisations whilst the second and third workshops were targeted towards a ground level practitioner audience, inviting practitioner representatives from Bureaux from across the UK.

The workshops focussed upon:

- Factors that contributed to the failings in the Shirley McKie case and other similar cases, including R v Smith in England and Wales;
- How these factors arose and practical mechanisms to address them; and
- The relevance of these factors to fingerprint practices in jurisdictions outside of the UK.

Current Projects of the Fingerprint Quality Standards Specialist Group

Code of Conduct and Annex of Fingerprints

This project aims to determine a good quality fingerprint standard with nationally agreed terminology for the purposes of ISO-17025 accreditation. This was presented in February 2014 at the Fingerprint Quality Managers Conference, and practitioners and the community were invited to formally provide feedback. The results are being collated and reviewed.

Primer for the Courts

This on-going project aims to provide an explanation of fingerprint examination terminology and procedures for a judicial audience.

Assessors Guide to Accreditation

UKAS assessors do not currently provide a technical assessment. The Fingerprint Quality Standards Specialist Group is looking to provide a guide for UKAS to give to their assessors to enable them to carry out this element of technical assessment.

Proficiency Testing

The Quality Standards Working Group is looking to set up its own internal proficiency-testing programme. This would mean that the bureaux that are represented on the working group would be able to validate each other's proficiency without the need for external input or for the procurement of consultancy services.

Enabling Partnerships for Innovation in Forensic Science

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