



B W J Rankin*, G Taylor and
T J U Thompson
School of Science and
Engineering
Teesside University
Middlesbrough TS1 3BA
*b.rankin@tees.ac.uk

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Should Higher Education respond to recent changes in the forensic science marketplace?

Abstract

The evolution of forensic science within the United Kingdom over the past four decades has been rapid and dynamic. This has included policy responses to highly public miscarriages of justice, introduction of commercialisation and pioneering scientific developments such as DNA profiling. However even within this context, changes within forensic science over the last two years has been unprecedented; such as the closure of The Forensic Science Service; a Home Office review of Research and Development within forensic science; the challenges facing fingerprint identification as a result of The Fingerprint Inquiry (Scotland) and the embryonic development of a new professional body for the police force.

Correspondingly, development of forensic science within Higher Education (HE) has been substantially transformed from a small number of Masters Courses in forensic science delivered by a small number of universities, to a plethora of undergraduate courses now available throughout the United Kingdom. This rapid expansion of forensic science courses has been openly criticised and debated^{1,2} and it is incumbent upon the university to not only focus on education but also to provide graduates with transferrable skills making them more employment ready³. As a consequence HE establishments must be cognisant of and reactive to changes within any associated industry and respond to changes accordingly. However, have the universities delivering forensic science courses fully responded to these recent and unprecedented developments in the history of forensic science within the United Kingdom?

This paper will consider the most recent changes to the forensic science marketplace and their ramifications for forensic science education within the HE sector. Challenges which have resulted from the changes will be highlighted and the educational impact on forensic science courses throughout the UK and their future will be evaluated in chronological order.

1. October 2010 – R v T

On the 26th October 2010 the Court of Appeal delivered its verdict on the appeal against the conviction of 'T' for murder (R v T [2010] EWCA Crim 2439). Of significant note, the three appeal judges, Lord Justice Thomas and Justices Beatson and Kitchen commented on the way in which crucial footwear evidence was presented. Berger *et al*⁴ stated that this judgement "caused considerable concern amongst forensic scientists within the UK and overseas" (p43) since they argued that the use of a probability-based statistical model could only be appropriately applied to quantitative data (such as DNA) and since this was not the case here, the original conviction was fatally undermined. For forensic science, this ruling is not as innocuous as it may initially seem. The key issue that many forensic practitioners publically noted^{4,5} is that it seems that the judges misunderstood the nature of the underlying statistical assumptions associated with the use of probabilities, namely the likelihood ratio. This is a ratio of two probabilities (so given a particular scenario in a forensic context, a hypothesis [prosecution] and alternative hypothesis [defence]) and it has been argued that there is nothing in the logical paradigm that surrounds this that requires the probabilities to be based on purely 'objective' data (Berger *et al.*, 2011). Furthermore, Berger *et al*⁴ argue that there is a difference between "using Bayes Theorem and following a Bayesian approach" (p48) which is essentially stating that there is a difference between using prior probabilities with associated statistical manipulation and merely adopting a logical approach when considering forensic evidence. However, it is argued that the two became conflated in the judgement⁴. Where the Court and the academics do agree, is in the need for transparency when delivered evidence and opinion where statistical or mathematical methods have been used^{4,5}.

Finally, it is important to remember that footwear evidence itself was not in question, merely the way in which it was evaluated and how that was presented to the Court. In this case it was not clear to the court that Bayes' Theorem had been used and the database information had been incorporated to provide a likelihood ratio – the notes and the final report did not match in terms of this detail (R v T [2010] EWCA Crim 2439). There are many databases in use within forensic science (see for example, Nordgaard et al.⁶), and while their use was not questioned, there was an implication that they needed to be of a certain size and form to allow for such statistical approaches to be used. Such is the complexity of this ruling and its implications that HE must respond. It is imperative that universities teaching forensic science address the fundamentals of Bayesian Theory (beyond the Bayesian approach) and spend time discussing the nature of likelihood ratios, and the differences between aleatory ('objective' and due to the

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randomness) and epistemic ('subjective' and due to limitations of knowledge) probabilities. The reality is that footwear examiners were likely doing this before the RvT ruling. However, the significance of RvT within forensic science can only be fully appreciated if the application of Bayes Theorem within other disciplines (ranging from archaeology⁷ to medicine⁸) is also examined. This allows students to critique this ruling by understanding how it is, or is not, accepted in other fields. Thus it can be seen that here, it is this specific forensic context which adds a problematic layer.

2. December 2010 – Closure of the Forensic Science Service

The Forensic Science Service (FSS) provided unparalleled expertise for forensic casework and research for many years in the UK and was respected worldwide. Thus, the surprise announcement of its closure made by the UK Government in 2010 sent a global shockwave throughout the profession. The FSS at that time delivered 60% of forensic services to police forces across England and Wales. However, the Home Office review highlighted the changing economic climate that the business had to operate within and the decrease in spending from police forces. Thus, the FSS closure was primarily due to the 'challenging forensic market' and the financial difficulties resulting from that⁹. One of the key priorities of the report was to ensure that a smooth transition to a new system which maintained quality would be paramount. One aspect of the report was to highlight the opportunity of creating a 'genuine' forensic science market and increase the effectiveness of the provision. The time frame given for closure was approximately two years (finally closing at the end of March 2012). As a consequence of the relatively short timeframe there would be a limited opportunity to ensure a viable alternative going forward. The closure of the FSS will impact the National Forensic Framework Agreement which incorporated standard specifications for a range of products which were to be provided by framework service providers. The impact of the closure of the FSS upon the HE sector can be perceived as negative and may impact on student perceptions of the industry, it may affect HE management decisions of courses to operate and HE academics who have liaised successfully with the FSS for many years to promote employability for graduates. But the emergence of new small-medium employers (SMEs) is an interesting growth area and one which is welcomed by the HE sector as increased opportunities for collaboration on a range of topics.

Furthermore, it is recognised and expected that considerable changes will occur within the National Forensic Framework Agreement to reflect the fact that existing and new companies are now doing the work originally done by the FSS. In fact, the demise of the FSS has resulted in a number of individual sole-traders and SME's being formed. As such, this may help nurture relationships between these companies and HE when recent graduates are employed. Thus importantly, the emphasis on collaboration and employability in current forensic science undergraduate courses must include awareness of private businesses within the forensic science sector. The FSS was an essential link to current research supporting HE establishments in a variety of ways including the provision of facilities for final year undergraduate projects at the cutting edge of forensic research, and with direct access to experts active in the field. Overall, the impact of the closure of the FSS upon HE is still relatively unclear and the full extent of the consequences of the loss of experience, expertise and professionalism will undoubtedly be debated for many years.

3. June 2011 – Review of Research and Development in Forensic Science

Following a number of significant developments within the forensic science arena, Professor Bernard Silverman (United Kingdom's Home Office-appointed Chief Scientific Advisor) was tasked with compiling an assessment of the research capabilities within UK forensic science. The resulting document (The Research and Development in Forensic Science: A Review) was published in June 2011¹⁰. The Review focuses on the key factors which influenced the closure of a major forensic provider (FSS), the distributed nature of the provision of forensic science in the UK, the rapid technological and methodological developments within forensic science and the changing provision of public sector funding for research¹⁰. Although, not explicitly mentioned in the report, the resulting ramifications of the Daubert rulings (see Sommer¹¹ and Page *et al.*¹² for greater discussion of these) may have influenced the timing of this review.

Silverman discussed¹⁰ the contribution of the Research Councils (RCUK) and Technology Strategy Board on the funding of forensic research in the UK. Interestingly, the perception in the field, which was articulated "*sufficiently often*", is that these national funders do not effectively support forensic science (p15). While RCUK argue¹⁰ that that "*work relevant to forensic science*" (p14) has been supported, it would be of interest to see whether these funded projects were pitched as forensic projects or whether the forensic contribution was incidental, and whether the PIs for these projects were active in the forensic field. Silverman strongly supports public funding of forensic science research¹⁰ since there is "*clear public interest in having the best possible scientific underpinning for the forensic work of the police, the criminal justice system and other users*" (p15). However, one major aspect that must be addressed when applying for funding is how to define forensic science. Academic disciplines actively debate the boundaries of their subject areas (e.g. Cattaneo¹³ and Dirkmaat *et al.*¹⁴ in forensic anthropology), and many (including forensic science) are inherently cross-disciplinary. All of this can make targeting appropriate funding bodies a challenging task. Furthermore, although research in forensic science occurs across universities, there is much occurring within post-92 institutions which can find securing funding more difficult.

The report listed eight recommendations which will be of interest to those involved in forensic science education¹⁰. These focussed on the responsibilities of the forensic providers' to undertake effective research; the significant impact that the Forensic Science Regulator can make (including his role in knowledge dissemination and communication through the facilitating of R&D conferences); the importance of strengthening linkages and communications between all stakeholders; and a reminder to RCUK and those associated with the forthcoming Research Excellence Framework (REF) of the complexities of the national arena of forensic science research and its importance to society.

This is a significant review which impacts on research, one of the pillars of HE. As such, it is incumbent upon HE in taking these recommendations forward. For example, there could be a greater emphasis on accessible dissemination (that is, not just restricted to academic journals) and one that includes a scheme to store nationally undergraduate and postgraduate research projects vis-à-vis the EThOS scheme, for PhD theses, that the British Library runs [www.ethos.ac.uk]. In fact, a scheme such as this for high-quality undergraduate research projects has just been proposed by the Higher Education Academy. Research questions explored could be more industry-oriented (or casework resultant) with support from the private sector. There could also be a national approach to research coordination to avoid repetition of work (also, see the comments above regarding the EThOS scheme).

4. October 2011 – A Review of Police Leadership and training includes the creation of a new professional body for policing.

In October 2011 it was announced that a new body will be responsible for setting professional standards, nurturing leaders and overseeing training for the 145,000 police officers in England and Wales. It will also control entry standards and promotion standards. The new body is expected to be established by the end of 2012 although the detail and intricate operations are unknown at this time. It is assumed that many of the National Police Improvement Agency (NPIA) functions will automatically transfer into the new professional body. However, it is unclear how the new body will operate within the policing environment including links with the Association of Chief Police Officers (ACPO), what membership categories there will be or how it will be funded. Currently, funding for professional bodies and learned societies is traditionally via its members subscriptions with a tiered level of membership fees from student to fellows.

Students, and lecturers for that matter, who enter professions should be encouraged to join appropriate professional or learned societies. The benefits of membership include networking opportunities to meet and discuss ideas, research and concepts with other professionals and importantly meet potential employers. Many societies run conferences, workshops and lecture series which enable students to input into the latest topics and importantly provide the opportunity to further their continuing professional development. This could also include the development of their Continuous Professional Competency. In addition, many bodies offer specific events for students which are slightly less formal and more flexible to deliver a research topic or poster presentation in a relaxed environment, both aiding communication and essential employability skills. The impact of the new police body on HE is currently unknown but if restricted to police officers may not be applicable to those working outside the police force. Either way, students and lecturers will need to be aware of the new police professional body and how it fits into the industry landscape by its relationship with the other professional and learned bodies.

5. December 2011 – The Fingerprint Inquiry Report / Scotland

A public inquiry was held in Scotland into the use and value of fingerprint evidence as a consequence of a specific murder case in 1997^{15, 16}. In summary, a fingermark had been found at the scene, on a bathroom door frame near where the body was found. This mark was identified as belonging to a police officer who had attended the scene but stated that they had not been near the bathroom. Preceding the murder trial the police officer was prosecuted for perjury and found not guilty. Two television programmes re-examined the case with additional experts and this continued the debate of whether the mark belonged to the police officer or not, driving further media and public attention. Subsequently, the Scottish Government announced an inquiry in 2008. The final report was produced in 2011 – nearly 800 pages and the full hard copy report weighing in at 7.7kg.

The report outlined the location and recovery of fingermarks at the crime scene and presentation of those fingermarks as evidence in court. One of the key findings of the report was the misidentification of the fingermark due to human error. However, the report also examined the theory of fingerprint examinations from their creation in the womb to the investigative aspects of location, recording and enhancement to the analysis, comparison, evaluation and verification of fingermarks. In summary, the report provided a rich and vast source of information which is applicable to higher education.

Overall the report produced ten key findings, ten key recommendations and eighty six further recommendations covering all aspects of fingerprint identification. The recommendations included the statement that fingerprint experts findings should be opinion as opposed to fact and there should be the introduction of new procedures for dealing with complex marks. Understandably, the depth of the report with its findings and recommendations will have implications for cases not only in the UK but worldwide.

Some of the key areas noted in the report that should be incorporated into university degrees, include:

- The overarching theme of forensic practice is the legal framework in which it operates. As a consequence the fundamental point for the student is to have an appreciation of the law with respect to civil and criminal burdens of proof – such as the criminal arena with 'beyond reasonable doubt'.
- Understanding the peculiar situation in which forensic science practitioners work is critical. As a forensic science practitioner you may be paid by a police force, a commercial provider or work within an SME. However, within the forensic context the findings, written or oral, will be relevant to the investigator but the overarching responsibility is to the court not the client or employer who pays the fee or salary. The student needs to approach their work with an open, yet questioning, mind knowing the Court is the ultimate customer. In addition, the courts (prosecution and defence) are expected to agree the common ground and argue the non-agreed areas of dispute. The student, as a potential expert witness, needs to be taught the Criminal Procedure Rules 2010 – part 33.2 to enhance their understanding of their court obligations.
- Coupled with the previous point is the understanding that the role of the forensic practitioner is to include, as well as exclude, someone or something from an investigation. Associated to this, the student needs to have the ability to demonstrate their technical work to a lay person in written reports or witness statements or orally in a court of law. These aspects need to be comprehensively covered and tested within the university courses.
- Scene or laboratory examination notes must be contemporaneous. It is vital that notes are made at the time of your examination or as soon practicable afterwards for all examinations. Any conclusions drawn from the examinations must be recorded in a clearly understandable manner – which will remain clear and understandable for months and even years after the completion of the work.
- The techniques used in examinations need to be validated. Learning and teaching in HE should also incorporate validated techniques. However these techniques may not be validated in the same way as forensic science providers who are required to be validated by the United Kingdom Accreditation Service (UKAS). Validation of new techniques is therefore an important consideration in research areas. The overarching principle here is the court requiring best evidence and if a new technique is not validated then the court needs to know this and include it in their deliberations.

One of the most interesting areas highlighted within the 'Scottish Inquiry' was the contextual influence that an individual can have on the result given by another individual. This was particularly relevant within the area of fingermark comparison checking as it is crucial for there to be peer checking and review within forensic practice. The use of peer checking and review procedures means a truly independent check on the work and the crucial findings without any bias or outside influence or pressure^{17,18}. To take a straight forward example, "*Can you see an '8' as part of this number recovery?*" This question is influencing and sows the seed of what the answer may be. So the question needs to be worded differently such as "*Can you see any digits in this area of chemical treatment?*".

Not all the findings and recommendations from the report are directly transferrable to the HE arena but there are many excellent learning points which lecturers need to be cognisant of to ensure the appropriate approach is followed, not only for fingerprints but also for forensic science practice in general. It could be argued that this single report has the highest impact and ramifications to education than the other current changes in the forensic market place highlighted in this paper.

6. The future changes 2013 – Accreditation

The need for learning and teaching quality within undergraduate courses is paramount for the future of forensic science in HE. Recent publications have highlighted the need for quality, academic rigour and transparency across forensic science courses within the UK¹⁹. Within the HE sector employability skills were one key area highlighted in order to improve quality, especially towards group work tasks and skills to meet the needs of forensic employers³. Most universities have now taken this on board and embedded group work modules throughout courses to meet the requirements of potential employers. Forensic science courses have the opportunity to be accredited by the Forensic Science Society (FSSoc), and Skills for Justice, skills mark. FSSoc currently have five component standards to which courses can be accredited and include crime scene investigation, laboratory analysis, interpretation, evaluation and presentation of evidence, computer network evidence recovery and digital evidence analysis, recovery and preservation.

Accreditation by the FSSoc demonstrates competence and excellence of teaching quality within HE establishments and helps maintain the recognition of standards in an accessible format for professional employers. Furthermore, the role of the other professional bodies and learned societies such as The Society of Biology, Royal Society of Chemistry, Fingerprint Society and The British Academy of Forensic Science also have key roles in supporting HE and the forensic employers towards accreditation. As such the importance of accreditation should not be underestimated as these are independent checks on the quality, which include specialist staff, academic content, facilities and industry engagement of forensic science courses. Accreditation and recognition also gives assurance and confidence to prospective students as well as employers and parents and importantly should be emphasised within marketing opportunities. Furthermore, the forthcoming Quality Assurance Agency (QAA) statement for forensic science adds another dimension for HE standards in teaching and learning.

ISO accreditation of forensic companies and more specifically the practices, policies and processes within forensic provision are now becoming an industry standard. The ISO/EC 17025 standard covers the competence of testing and calibration within laboratories. Thus, many laboratories who are not wholly dedicated to forensic work depend on this standard to show awareness and accreditation of their laboratory processes and practices. The recognition of ISO/EC 17025 and ISP 17020 (scenes) standard will become increasingly important as new and existing companies migrate into forensic work to show competency. It raises the interesting question as to whether those university laboratories which teach forensic science should operate to comparable standards. Recently, United Kingdom Accreditation Service (UKAS) granted the accreditation of the first ISO/EC 17020 for the examination of crime scenes to Orchid Cellmark Ltd. The impact of accreditation upon HE will be significant and of high importance, as ISO 17020 and 17025 (scene and laboratory respectively) are of paramount importance for forensic providers and should be taught and embedded within HE courses.

Conclusions

The recent unprecedented changes within forensic science have been evaluated and it has been clearly demonstrated that they provide a challenging new era for HE. This is particularly relevant in these unsettled times of austerity and the continual need to provide value for money. Institutions delivering forensic science will need to balance responding to these changes in the forensic science market place with their broader response to the changing HE environment. Nonetheless, the response by HE needs to be positive to ensure a sustainable future for students studying forensic science. The new era of employment-ready students is paramount to establishing how forensic science courses are developed and delivered. It should not be forgotten that forensic science courses have an important contribution to make to the generic employment-ready scientific graduate agenda since they provide students with many transferable skills (such as problem solving, oral/written communication), as well as laboratory and critical skills that go beyond the forensic context itself.

Recent publications have highlighted the need for quality, academic rigour and transparency across forensic science courses within the UK.

Forensic science teaching at HE is intrinsically linked to the forensic marketplace and HE students need an understanding of why and how their knowledge and learning during HE develops into the life-long skills needed by a range of employers. As such, and as has been highlighted above, the contribution of the forensic industry in many aspects of forensic science education will be paramount. This needs to go beyond the 'guest lecture' approach, but rather involve those working in this fluid marketplace contributing to module and assessment design and research questions and infrastructure. This is the only way to fully and comprehensively

address the above while also ensuring rapid response to potential future changes.

Finally, one of the most positive themes within the HE sector and forensic science practitioners is the level of interest and enthusiasm that still prevails. The impact of the media, available vocational courses and diverse careers opportunities should not be underestimated for the recruitment of new forensic science students. Despite the significant changes and challenges affecting the forensic industry and the HE sector, the future for forensic science students is positive provided that their courses are based upon core scientific concepts which deliver the transferrable skills needed by employment-ready graduates in the new forensic science marketplace.

References

1. House of Commons Science and Technology Committee. (2005) Forensic Science on Trial. The Stationery Office, London.
2. Hannis, M. and Welsh, C. (2009) Fit for Purpose? Research into the provision of Forensic Science degree programmes in UK HEIs. Skills for Justice.
3. Hanson, S. and Overton, T. (2010) Skills required by new forensic science graduates and their development in degree programmes. The Higher Education Academy.
4. Berger, C.E.H., Buckleton, J., Champod, C., Evett, I.W. and Jackson, G. (2011) 'Evidence evaluation: a response to the court of appeal judgment in RvT'. *Science & Justice* 51, 43-49.
5. Robertson, B., Vignaux, G.A. and Berger, C.E.H. (2011) 'Extending the confusion about Bayes'. *The Modern Law Review* 74, 430-455.
6. Nordgaard, A., Hedberg, K., Widén, C and Ansell, R. (2012) 'Comments on "The database search problem" with respect to a recent publication in Forensic Science International'. *Forensic Science International* 217, e23-e33.
7. Lewis, M. and Gowland, R.L. (2007) 'Brief and precarious lives: Infant mortality in contrasting sites from medieval and post-medieval England (AD 850-1859)'. *American Journal of Physical Anthropology* 134, 117-129.
8. Berry, D.A. (2012) 'Bayesian approaches for comparative effectiveness research'. *Clinical Trials* 9, 37-47.
9. House of Commons Science and Technology Committee: The Forensic Science Service, Seventh report of session, 2010-2012. (2011) The Stationery Office, London.
10. Silverman, B. (2011) The research and development in forensic science: a review. Home Office.
11. Sommer, P. (2010) 'Forensic science standards in fast-changing environments'. *Science & Justice* 50, 12-17.
12. Page, M., Taylor, J. and Blenkin, M. (2011) 'Forensic identification science evidence since Daubert: Part 1 – A quantitative analysis of the exclusion of forensic identification science evidence'. *Journal of Forensic Sciences* 56, 1180-1184.
13. Cattaneo, C. (2007) 'Forensic anthropology: developments of a classical discipline in the new millennium'. *Forensic Science International* 165, 185-193.
14. Dirkmaat, D.C., Cabo, L.L., Ousley, S.D. and Symes, S.A. (2008) 'New perspectives in forensic anthropology'. *Yearbook of Physical Anthropology* 51, 33-62.
15. Fingerprint Inquiry. <www.thefingerprintinquiryscotland.org.uk> (date accessed 20th April 2012).
16. Forensic Science Regulator. Response to the fingerprint inquiry. <www.homeoffice.gov.uk/publications/agencies-public-bodies/fsr/dev-quality-std-fingerprint-exam?view=Binary> (date accessed 20th April 2012)
17. Kaye, D.H. (2012) The design of "the first experimental study exploring DNA interpretation". *Science & Justice* 52, 126-127.
18. Dror, I.E. (2012) Cognitive forensics and experimental research about bias in forensic casework. *Science & Justice* 52, 128-130.
19. Welsh, C. and Hannis, M. (2011) 'Are UK undergraduate Forensic Science degrees fit for purpose?' *Science & Justice* 51(3), 139-42.

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