University of Edinburgh – Written evidence (FRS0067)

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1. Introduction

This document provides a response to the questions posed by the House of Lords Science and Technology Select Committee as part of its Forensic Science Inquiry. The authors are affiliated to the University of Edinburgh which has been an internationally leading centre for fire safety science and engineering research and education since the mid 1970s, and was the first institution globally to offer a Masters degrees in this discipline (in 1974). In 2013, Dr Rory Hadden was appointed as the inaugural Rushbrook Lecturer in Fire Investigation. The fire safety engineering group at Edinburgh currently comprises 9 academic staff and more than 25 full time PhD students.

1.1 Scope

The authors are experts in forensic fire investigation. Therefore, the content of this submission is restricted to this field.

In responding to the questions, no comments are made pertaining to digital forensics however it is anticipated that these will play an increasing role in future fire investigations.

The questions are answered in the order they are presented after a short discursive section. Note that we have chosen not to address all questions.

2. About the authors

Dr Rory Hadden. Rushbrook Senior Lecturer in Fire Investigation at the University of Edinburgh. He graduated in 2007 with a first-class MEng in Chemical Engineering and in 2011 with a PhD in Fire Safety Engineering from the University of Edinburgh. He subsequently held postdoctoral research positions at the University of Western Ontario and Imperial College London before joining the University of Edinburgh as academic staff in 2013. His research has focussed on advancing the understanding of the ignition, flame spread, and burning of solid fuels with application to initiation and spread of fires in the built and natural environments.

Professor James Lygate. Chairman and Principal Investigator, International Fire Investigators and Consultants and Visiting Processor University of Edinburgh. He has a BSc in Surveying and an MSc in Fire Engineering (University of Edinburgh). He is a Chartered Engineer and Fellow of the Institution of Fire Engineers and a Fellow of the Royal Institution of Chartered Surveyors. His experience includes investigation of industrial, commercial and residential fires and explosions, electrical causes of fire, and fires in vehicles. He is internationally renowned for his expertise pertaining to ship fires and explosions. An experienced author of reports for Insurers, Solicitors and Attorneys, his reports have been submitted to courts around the world and the United Kingdom where he has frequently given expert evidence in court.
3. Fire investigation: the challenges

Although here are many similarities between fire investigation and other forensic disciplines, there are some stark differences.

- Fire Investigation is highly multidisciplinary.
- There are no standardized techniques.
- There is very little fundamental scientific literature on which many aspects of fire investigation are based.
- In many cases the evidence of a crime is destroyed rather than created during a fire.
- Practitioners come from a range of diverse backgrounds making definition of a competent practitioner difficult.
- There is no formal educational qualification in fire investigation.
- The fire investigator must have a diverse range of skills from fundamental science, engineering and chemistry, these are not covered in forensic science education.
- Crimes in which a fire investigator may be required are rare.
- Unclear ownership of ‘the fire problem’ (who does society expect to be knowledgeable on this issue?).
- The balance of knowledge claims substantiated by experience versus knowledge claims substantiated by formal education.
- The need for certainty in the justice system where it may not be possible to provide such.

These points mean that fire investigation faces particular challenges: What skills should a practitioner have? What level of certainty can be applied to an investigation given the lack of fundamental science on which it is based? Does the UK have sufficient capacity when there is a large fire to ensure an appropriate level of insight?

Historically when criminality was suspected around involving a fire, the police could draw upon the expertise of the Forensic Science Service. The staff there developed and pioneered many of the fire investigation methods in use today. Given the relatively rare nature of crimes involving fires, this meant that a cohort of practitioners who were operating within the same organization and able to develop and apply their skills could be retained. Knowledge transfer occurred efficiently, and, more importantly, knowledge could be retained as careers changed. With the current market-driven approach to forensic science, niche areas such as fire investigation, will suffer as there are few opportunities to develop skills and there is insufficient opportunity (business) to allow individuals to specialize in fire investigation (in some cases this is mitigated by undertaking investigations in Civil cases). This causes a gradual reduction in the quality of fire investigations as knowledge is lost.

This naturally follows on to the question of what skills should a fire investigator have? Fires are physical processes that are governed by heat transfer, fluid mechanics and chemistry. To interpret a fire science and the associated evidence, knowledge and understanding of these concepts at a level comparable to a higher education degree (BSc, MSc) is, in our view, an appropriate basis for a fire investigator. These are topics covered by mechanical, chemical or civil engineers. These are partly covered by degrees in the pure sciences but rarely is
heat transfer or fluid mechanics taught to a sufficient level on many Forensic Science Degree programmes. There are few institutions in the UK where these topics are combined specifically to focus on fire science. This has been the motivation for the degree programme at the University of Edinburgh. It is a reality that many fire investigators have experience in the fire service. This experience is extremely valuable, however, it does not automatically follow that they also have the appropriate skills and competencies in the above topic to compliment this experience and therefore prior to entering a forensic discipline, appropriate personal development should be sought.

Fire science has not seen the rapid advances in knowledge and techniques that has been characteristic of other forensic disciplines in recent years. Although there is a science base, this is not always straightforward to apply to fire scenes and requires a high degree of education to do so in a quantitative way. This lack of science stretches to core areas of fire investigation such as pattern analysis, material response and effect of, and upon, building systems. These knowledge gaps urgently need to be filled such that fire investigation can keep pace with the advances in the built environment. Clearly the development of new science is closely linked with the competence of the individuals applying this knowledge. Consequently, this aspect is linked to the skills issue above.

Capacity is a key challenge in the UK. The large-scale facilities available nationally cannot accommodate the kind of work necessary for fire investigations which typically require extended duration use of space and generally a large area to enable reconstruction. Such facilities that do exist nationally may be compromised by the need to maintain activity in other areas e.g. product/system testing. Furthermore the organizations which operate these may be subject to commercial conflicts.

In summary fire investigation in the UK is hindered by:

- An unclear definition of the competencies required by the fire investigator;
- Marketisation which has resulted in loss of specialism and knowledge from the community;
- A solid underpinning in fundamental science and a profession with the skills to apply this;
- A lack of national capacity to undertake forensic investigations;
- There is no adequate mechanism by which failings identified during fire investigations can be returned to the regulation and design process.

4. Response to Questions

4.1 General

4.1.1 Is forensic science contributing to the delivery of justice in the UK?

In general yes. There are checks and balances in the presentation of forensic fire investigations that mean there is a reduced chance of errors being carried through the system. However, there remains a lack of clarity on who has the appropriate competence to investigate fires. The fire engineering design community does not generally undertake forensic work.
4.1.2 What are the current strengths and weaknesses of forensic science in support of justice?

In the context of fire investigation, we do not see any specific strengths. There is no centralised public body that ensures consistency of deliver, the knowledge claims made are often unsubstantiated or based on limited scientific data. “Grandfathering” of myths, though improved significantly in recent years, persists. Many practitioners lack the formal educational background that is required to interpret the processes that govern a fire in a quantitative sense. The largest weakness therefore is the lack of scientific data to underpin the conclusions drawn in fire investigations and there being a consistent level of competency across the practitioners.

4.2 Understanding and use of Forensic Science in the Criminal Justice System

4.2.1 What is the scientific evidence base for the use of forensic techniques in the investigation and prosecution of crimes? Are there any gaps in that evidence base?

There is very little evidence on which to base interpretation of fire damage, fire patterns or other evidence at a crime scene involving a fire. The fire may destroy evidence and the evidence generated presents many challenges for interpretation.

4.2.2 How can the Criminal Justice System be equipped with robust, accurate and transparent forensic science? What channels of communication are needed between scientists, lawyers and the judiciary?

In the case of fire investigation, the CJS, and the actors therein, must appreciate that fires are physical processes that are governed by known scientific principles. This does not mean that solutions are simple to identify but that, although the knowledgebase is small, systematic interpretation of fundamental principles in a sound manner can allow conclusions to be drawn.

4.2.3 What is the level of understanding of forensic science within the Criminal Justice System amongst lawyers, judges and juries? How can it be improved?

In general, people are familiar with fire. However, this means that they bring their own preconceptions to the what can and cannot be understood in a scientific context. It is common to hear fires described as ‘chaotic’ and ‘unpredictable’, neither of which are strictly true, or for a fire to be described using imprecise, emotive. This terminology and these preconceptions need to be effectively dispelled by the expert who must present their interpretation in the same quantitative terms as any other forensic discipline.

4.2.4 Is the current training available for practitioners, lawyers and the judiciary appropriate?
A substantial amount of time can be devoted in court to assisting Judges, Juries, Barristers and Lawyers understand the nuances of complex scientific concepts. Practitioners in the UK Fire Service receive on-the-job training delivered by third party organisations who subcontract the training to private contractors. The quality is variable and requires to be improved by goal setting and monitoring by the Forensic Regulator.

4.3 Standards and regulation

4.3.1 Is the current market for forensic services in England and Wales sustainable? Are changes needed to ensure forensic science provision is maintained at the level required? What are the risks of a market approach, for example what happens if a provider goes out of business? And what is the impact on quality?

We consider that the status quo is unsustainable. The nature of fire investigation is that the events which demand forensic investigation are rare. Nevertheless, they require a high level of understanding in order to investigate fully and to draw conclusions, make secure convictions and ultimate feedback to the design regulations. At present, the commercial market puts pressures on generalisations rather than specialisations in forensic science. A scientist with skills in, for example, analytical chemistry is unlikely to also have the skills necessary to practice fire investigation.

If a provider goes out of business, then the expertise held within the UK community will diminish. The repercussions of this are obvious. As knowledgeable practitioners are lost, the state of the art will not be upheld and standards will shrink. Fire investigation is a specialised field and it is not easy to educate individuals with the skills necessary to investigate fires (as for example it might be possible in a highly standardised area such as chemical analysis) due to the limited number of institutions offering appropriate qualifications and the length of time required to undertake these programmes.

4.3.2 Is the system of accreditation working successfully to ensure standardised results and the highest quality analysis and interpretation of significance of evidence?

Accreditation can improve the quality of forensic services only when there is an appropriate level of competency within the profession. It is important that these issues are not conflated. This is important when considering the education versus experience approach often applied to differentiate between experts. It is not for an expert to demonstrate that they followed procedures but rather for them to demonstrate why they are competent to interpret evidence that is often complex in nature.

4.3.3 What role should the Forensic Science Regulator have? If the Forensic Science Regulator is to have statutory powers, what should these be?

The Forensic Regulator considers that Organisations conducting fire investigations in the criminal justice system should be accredited to ISO 17020 which is a standard for the collection and interpretation of evidence. This novel
approach is being pioneered in conjunction with UKAS. We agree with the Regulator’s view that organisations offering fire investigation should be accredited. It remains to be seen whether or not ISO 17020 is an appropriate and workable standard. There will be significant cost implications in organisation being accredited to and working in compliance to ISO 17020.

4.3.4 What lessons can be learned from the use of forensic science in Scotland and Northern Ireland? What can be learned from the use of forensic science overseas?

In Scotland, there is centralised provision of forensic services. This is a large advantage in terms of retaining knowledge and sharing best practice. This model allows a centralised approach and the retention of knowledge in key areas.

4.3.5 Is the ‘Forensic Science Strategy’ produced by the Home Office in 2016 suitable?

No comments.

4.4 Forensic Science research landscape

4.4.1 How should further research funding for forensic science be justified? What should be the focus of such research? What is the role of UK Research and Innovation, especially considering the interdisciplinary nature of much forensic science?

At present there is very limited fundamental science to underpin forensic discipline. The justification for further research in this field is that this will enable better certainty in investigation findings and reduced reliance on opinion evidence. In addition this will feedback to design and regulation processes. At present there is a complete disconnect between those who design infrastructure and those who investigate the failures due to fire. The complex systems that are installed protect assets from fires are rarely tested therefore it is essential that when there are faults these are properly investigated, and findings are communicated widely. At present there is no simple way for this to occur. UKRI has a key role in supporting these developments through supporting fundamental research in areas where there are knowledge gaps or uncertainty in the validity of techniques.

4.4.2 Where are the gaps in research and understanding of forensic science? How and by whom should the research questions be articulated to fill these gaps?

There are many areas in which forensic fire investigation would benefit from fundamental research. These topics include:

- Post-flashover fire pattern interpretation.
- Electrical fault diagnosis and ignition risk.
- Interpreting fire spread in infrastructure build using new construction techniques (modular construction, modern material etc).
- Arson indicators in outdoor fires
Research questions should be articulated by the fire investigation community in conjunction with fire engineers responsible for the design, installation and operation of fire protection systems. The UK has an active fire science research community with skills, expertise and capital infrastructure required to advance the state of the art in these areas.

4.4.3 How can a culture of innovation in forensic science be developed and sustained?

A long-term research and strategy developed with UKRI and underpinned with industrial support is required. This will enable forensic science to be explicitly linked with developments in physical science. Again, the market-driven nature of the provision does not encourage investment in niche areas such as fire investigation so this would assist in leveraging resource.

There is a further opportunity to use forensic fire investigations to identify research needs to drive safety and assess the applicability of relevant safety standards.

4.4.4 Are there current or anticipated skills gaps? Who should have responsibility for and/or have oversight of training?

There are clear gaps in the skills of fire investigators. The current market-driven approach means that specialising in fire investigation is not profitable (historically there are few convictions, few corporate manslaughter charges brought due to fire). Although this situation is to be celebrated, when a significant fire, where multiple parties may require representation, occurs there is insufficient capacity to allow for investigation this.

The oversight of training for fire investigation needs to involve the higher education sector. Training is insufficient to ensure good outcomes, the starting point must consider the baseline knowledge of the practitioner. The processes which govern fires are complex and a clear need exists to equip investigators with the quantitative knowledge to produce high quality investigations. The current Skills for Justice qualifications are a good starting point but for complex investigations these may not be sufficient.

Our view is that competency should be assessed by peer-recognition e.g. a Chartership system as used in the Engineering sector. This body would be responsible for defining the competencies required and assessing practitioners against these.

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