Australian Government
Australian Research Council

EI 2018 ENGAGEMENT AND IMPACT

Engagement and Impact 2018

University of Technology Sydney

UTS03 (ST) - Impact

Overview

Title

(Title of the impact study)

Development and validation of new fingerprint detection techniques for a more effective law enforcement and criminal justice system

Unit of Assessment

03 - Chemical Sciences

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

81 - Defence

94 - Law, Politics and Community Services

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

77 - Public Order, Safety and Regulatory Services

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Fingermarks

Fingerprints

Forensic chemistry

Law enforcement

Criminal justice

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?
NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

No

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

Law enforcement and counter terrorism organisations worldwide use procedures and standards arising from research at UTS's Centre for Forensic Science (CFS) to develop and interpret fingerprints that are often invisible on surfaces touched during criminal activity.

The CFS has defined, invented and improved techniques that enable the criminal justice system to more effectively detect criminals, prove their involvement and eliminate suspects whose fingermarks do not match those on evidence.

The impact of this research comes mainly from developing techniques that are easier, faster and safer to use and that maximise the quantity and quality of fingermarks that can be recovered.

One of its most impactful discoveries is known internationally as the 'Australian formula'.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

Australian Federal Police

New South Wales Police Force

Department of Home Affairs (formerly Immigration and Border Protection)

Victoria Police

UK Home Office

Israel Police

Royal Canadian Mounted Police

US Secret Service

Instrument manufacturers (e.g. Rofin Australia)

Australian and international courts

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia
England
Scotland
Wales
Canada
United States of America
Israel
Brunei Darussalam
New Zealand
Papua New Guinea
Romania

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:
- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of those affected, reported benefits etc.)
- the dates and time period in which the impact occurred.

NOTE - the narrative must describe only impact that has occurred within the reference period, and must not make aspirational claims.)

The Centre for Forensic Science is recognised as a world leader in the field of fingerprint research, and CFS research has set standards used worldwide. This research has enabled an increasing proportion of latent fingermarks to be available and matched to known fingerprints or other fingermarks. The CFS's impact has been exceptionally high in fingermarks on surfaces that are difficult for powdering and other traditional techniques. The complexity of fingermarks is partly due to the interplay between the substrate and the environment where the mark is made and subsequent environmental exposures. Different methods find different marks.

In 2002, CFS and the AFP jointly developed a way to detect fingermarks on the polymer banknote. The AFP immediately implemented this vacuum metal deposition methodology as a standard operating procedure (SOP). The AFP reports that it "has been used to examine both polymer currency and other plastic items in a large range of cases resulting in the development of numerous fingerprints." Continued collaboration has further improved the technology and "made processing less time-intensive," the AFP says. Other countries where polymer banknotes are in circulation followed: Canada, the UK, Brunei, NZ, PNG, Romania and Vietnam. This process is recognised globally as the best for finding fingermarks on polymer notes.

UTS showed how to make consistent, reliable use of 1,2-indanedione-Zn that was initially suggested in the 1990s for use on paper or porous surfaces. This method had advantages over the existing process in its sensitivity, fluorescence, speed and ability to work effectively in both white light and fluorescence mode. However, validation around the world – even within Australia and across seasons – had vastly different results. In 2007–11, a collaboration between the CFS, the University of Canberra and the AFP identified the chemistry causes, and by adding zinc into solutions, they overcame the inconsistencies. Their solution is now known internationally as the

"Australian formula".
CFS also found how to overcome the barriers to use of cyanoacrylate in fingermark detection. They recommended a temperature limit to avoid risks of irritation and cyanide's lethality. These recommendations have been implemented in forensic science laboratories internationally since 2011. CFS has also improved operational workflows:

•A faster, simpler 1-step process validated at CFS brings the laboratories closer to replace an existing 2-step process.
•Integrating fingerprint and DNA techniques has optimised recovery of both evidence types and reduced the destruction of crucial evidence.
•Improved knowledge on substrates and environments has led to better selection/choice of techniques.

Two other CFS techniques improved the sensitivity and selectivity of detection of marks that would be otherwise missed, especially on difficult surfaces due to background interference:

•Cutting-edge methods to detect and enhance fingerprints using hyperspectral imaging
•Detection using anti-Stokes luminescence.

INTERPOL has highlighted the international significance of UTS's research. Its Forensic Sciences Managers' Symposium reports on every forensic science research publication across the world. The most recent report (Oct 2016, with publications Jul 2013-Jul 2016) highlighted 61 papers on fingermark detection, of which 13 were authored by CFS members. That means 21.3% of the most relevant international research that was deemed excellent and impactful originated from CFS. Further, three of the four papers highlighted in the Symposium's oral presentation on critical advances listed at least one CFS author (the fourth had a CFS associate member).

The UK Centre for Applied Science and Technology (CAST) Fingermark Visualisation Manual (FVM) incorporates several aspects of CFS research:

• CAST confirmed the potential of multispectral imaging to reveal fingermarks not possible by other means. Some UK police forces followed CAST in buying imaging systems in the late 2000s. At least one 'stranger rape' was solved using the system. CAST included multispectral imaging in the FVM in 2014.
• CFS "made 1,2 indandione far more widely adopted worldwide, and using the Australian formulation as a starting point CAST conducted reformulation work between 2013–2016 and now has a 1,2 indandione-zinc formulation optimised for UK conditions."
• CAST reports "The work carried out on the polymeric Australian banknotes…has long been regarded as the definitive study…and gave important information about which techniques are capable of developing marks on this type of surface. We published the processing routes suggested by Prof. Roux's group in the FVM in 2014, and used this as the basis of our research when the UK started issuing polymer banknotes in 2016."
• CAST had suspected that harmful breakdown products were likely to form during cyanoacrylate fuming. "The health and safety research by Prof. Roux's team…enables us to respond to enquiries from our stakeholders."

The Latent Fingerprint Lab of the Israel Police said: "we rely very much on the excellent work of our Australian colleagues [and] confirm that… the centre of forensic science has made an important impact on operational casework in the Israel Police". In particular:

• CFS's work "changed the protocols of development of polymer banknotes in Israel in such a way that we now use vacuum metal deposition as a routine part of the protocol".
• "Most operational units including our own did not include [indanedione Zn] since its results were unstable and unrepeatable. The debate…on this reagent went on for years until the 'Australian formula' as it is still called today was published in 2007. As a result, we chose to include this reagent in our operational work [and] we report 30% more fingermarks in our cases today."
• CFS research has enabled the Israel Police to implement safety measures for field technicians who work with fuming cabinets.

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:
- what was researched
- when the research occurred
- who conducted the research and what is the association with the institution)

The polymer banknote research was undertaken in 1999-2003 by:
•Claude Roux at UTS
•Chris Lennard and Milutin Stoilovic from the AFP
•HDR student Naomi Speers (nee Jones)

The 'Australian formula' was created in 2007-11 by:
•Claude Roux
•Chris Lennard from the AFP and then University of Canberra
•Milutin Stoilovic from AFP
•HDR students Xanthe Spindler and Christie Wallace

Research addressing cyanoacrylate fuming was undertaken in 2010-11 by:
•Claude Roux, Xanthe Spindler and Ronald Shimmon at UTS
•Chris Lennard at the University of Canberra
•Jennifer Raymond at NSW Police Force
•Honours and HDR students Carlos Fung and Alicia Khuu.

Operational workflows improvements began in 2015 with:
•Claude Roux, Xanthe Spindler, Sebastien Moret, Scott Chadwick and Peter Gunn at UTS
•Chris Lennard at Western Sydney University
•Jennifer Raymond at the NSW Police Force
•HDR student Alicia Khuu

Use of hyperspectral imaging was developed in 2005 by technology transfer and rescaling from the military and aerospace industry to tackle background interference by:
•Claude Roux and Brian Reedy at UTS
•Chris Lennard from the AFP
•HDR students Mark Tahtouh and Gemma Payne

Development of detection techniques using anti-Stokes luminescence involved technology transfer from materials nanotechnology and was undertaken in 2011-12 by:
•Claude Roux, Andrew McDonagh, Philip Maynard and Ronald Shimmon at UTS
•Chris Lennard at the University of Canberra
•HDR student Rongliang Ma

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

02 - Physical Sciences

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

Jones, N., Kelly, M., Stoilovic, M., Lennard, C., Roux, C. The development of latent fingerprints on polymer banknotes. Journal of Forensic Identification. 2003;53:50–77.

Payne G., Reedy B., Lennard C., Comber B., Exline D., Roux C. A further study to investigate the detection and enhancement of latent fingerprints using visible absorption and luminescence chemical imaging. Forensic Science International, 150:1, 2005, 33-51. DOI: 10.1016/j.forsciint.2004.06.036

Tahtouh M., Kalman J.R., Roux C., Lennard C., Reedy B.J. The detection and enhancement of latent fingermarks using infrared chemical imaging. Journal of Forensic Sciences, 50:1, 2005, 64-72.

Exline D.L., Wallace C., Roux C., Lennard C., Nelson M.P., Treado P.J. Forensic applications of chemical imaging: Latent fingerprint detection using visible absorption and luminescence. Journal of Forensic Sciences, 48, 2003, 1047-1053

Ma R., Shimmon R., McDonagh A., Maynard P., Lennard C., Roux C. Fingermark detection on non-porous and semi-porous surfaces using YVO4:Er,Yb luminescent upconverting particles, Forensic Science International, 217 (1-3), 2012, e23-e26. DOI: 10.1016/j.forsciint.2011.10.033

Moret S., Spindler X., Lennard C., Roux C. Microscopic examination of fingermark residues: Opportunities for fundamental studies, Forensic Science International, 255, 2015, 28-37. DOI: 10.1016/j.forsciint.2015.05.027

Khuu, A., Chadwick, S., Spindler, X., Lam, R., Moret, S., & Roux, C. Evaluation of one-step luminescent cyanoacrylate fuming. Forensic science international, 263, 2016, 126-131. DOI: 10.1016/j.forsciint.2016.04.007

Raymond J., Roux C., Du Pasquier E., Lennard C., Sutton J. The Effect of common fingerprint detection techniques on the DNA typing of fingerprints deposited on different surfaces. Journal of Forensic Identification, 54(1), 22-44, 2004.

Fung, T.C., Grimwood, K., Shimmon, R., Spindler, X., Maynard, P., Lennard, C., Roux, C. Investigation of hydrogen cyanide generation from the cyanoacrylate fuming process used for latent fingermark detection, Forensic Science International, 212 (1-3), 2011, 143-149. DOI: 10.1016/j.forsciint.2011.06.004

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:
- name of indicator (100 characters)
- data for indicator (200 characters)
- brief description of indicator and how it is calculated (300 characters).)