# CURRENT STATUS REPORT

Forensic Science Research and Innovation

Australia and New Zealand

2017

ANZPAA

Australia New Zealand Policing Advisory Agency

NIFS

National Institute of Forensic Science Australia New Zealand

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# INTRODUCTION

The Australia New Zealand Policing Advisory Agency (ANZPAA) National Institute of Forensic Science (NIFS) Research and Innovation (R&I) Strategy and Roadmap Project aims to outline research priorities for forensic science in Australia and New Zealand over the next five years. The Roadmap will have a view to forensic science in 2030 and will assist industry, academia and ANZPAA NIFS in preparing each of the forensic science disciplines for the future by tailoring research to the identified needs of the community. Furthermore, the outcomes of the Strategy will improve the service that forensic science provides to the policing and intelligence environments.

The ANZPAA NIFS R&I Strategy and Roadmap Project Survey was disseminated to forensic science service providers, academic institutions and forensic technology providers in 2016 in an effort to identify the current, proposed and future initiatives in forensic science R&I across Australia and New Zealand. The purpose of this report is to provide a summary of the current initiatives identified throughout the survey process. The information contained in this report informs the current state of R&I and demonstrates the point at which the Roadmap will need to commence in order to realise the future goals of forensic science in Australia and New Zealand. It also identifies valuable partnerships between organisations that should be further developed through the Strategy and Roadmap.

The specific detail of each of the projects has not been included; rather, a high level summary of the work being performed without reference to individual organisations has been provided. The specific detail of each of the projects will continue to be considered in the development of the Strategy and Roadmap.

# CURRENT INITIATIVES

The current research and innovation initiatives identified through the ANZPAA NIFS R&I Strategy and Roadmap Project Survey, have been collated and grouped according to disciplines consistent with the current Specialist Advisory Groups (SAGs) managed by ANZPAA NIFS. Where responses did not fit within one of the SAGs, a category of 'other' has been included:

- Biology
- Chemical Criminalistics
- Crime Scene and Ballistics
- Document Examination
- Electronic Evidence
- Fingerprints
- Illicit Drugs
- Medical Sciences
- Toxicology
- Other

Across the nine SAG disciplines, approximately 250 individual initiatives were identified. A breakdown is provided in Figure 1 below, however it should be noted that some of these initiatives are made up of multiple projects and that initiatives which spanned multiple disciplines have been omitted.

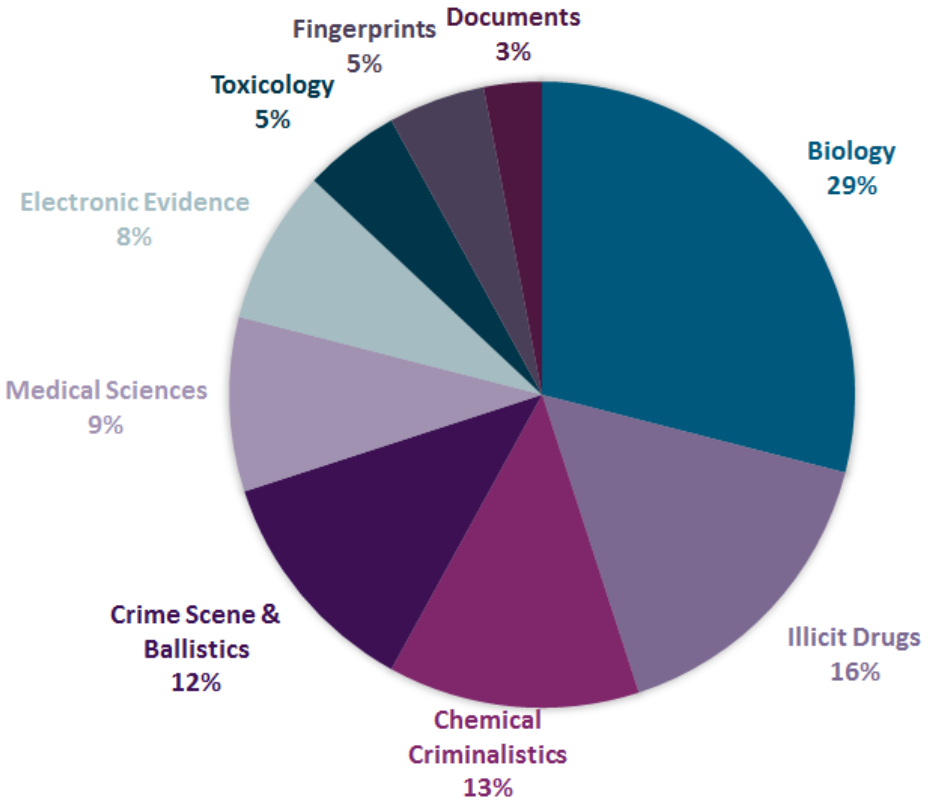


**Figure 1 – Current R&I initiatives by SAG discipline**

# BIOLOGY

The field of forensic biology in Australia and New Zealand has made significant advancements in recent years, moving to an expanded DNA marker set and a probabilistic genotyping solution for reporting of results. Advances in sequencing technology means that Massively Parallel Sequencing (MPS) is ready for serious consideration, however it remains unclear how much of a priority this is for the Australian and New Zealand forensic landscape. This is one of the major issues facing forensic biology and the Biology Specialist Advisory Group (BSAG) have identified this as well as the use of activity level reporting, rapid DNA technology and national familial DNA searching as critical issues to address in the immediate future.

## STRENGTHENING CURRENT TESTING CAPABILITIES

The initiatives currently underway include validation of upgraded capillary electrophoresis (CE) instrumentation, increased use of robotic platforms to increase capacity through automation and consideration of new STR profiling techniques to enhance the information provided to law enforcement agencies. As part of this consideration, work is being performed to assess success rates of the commercially available kits as well as a cost benefit analysis of introducing additional testing options. Sub-population datasets as well as the Y-STR population dataset are currently being reassessed, in an effort to strengthen the evidence that is provided as a result of the testing. A number of jurisdictions also monitor success rates yearly, in an effort to inform sample collection procedures to increase efficiency.

## SAMPLE COLLECTION AND SCREENING

The area of sample collection continues to be a priority, with projects investigating the persistence of spermatozoa on items of clothing that have been washed and the use of tapelifting to collect spermatozoa from difficult substrates. A new fibre and capture device is in development under patent as well as a commercial DNA marker spray screening tool to detect cellular material not visible to the naked eye. There are also active projects developing methods for identifying and selecting single cell types for subsequent DNA analysis in an effort to use physical separation techniques to increase the chance of generating single source DNA profiles.

Collection of material from different surfaces is being investigated, including Electrostatic Detection Apparatus (ESDA) film in cases involving forensic document examinations, and the effect of other forensic processes on DNA analysis, such as the use of fingerprint powder is also being assessed. Body fluid identification is being furthered developed, investigating new commercially available screening techniques and developing expertise using RNA markers as a confirmatory test. DNA transfer and persistence projects are ongoing, with an increased focus on the transfer of low level trace DNA during normal activity and the implications for criminal casework given the heightened sensitivity of current generation STR profiling kits.

## SAMPLE PRESERVATION AND STORAGE

Options for the transport and storage of DNA continue to be developed, with the effectiveness of commercial products which allow this to occur at room temperature, such as DNAStable®, currently being assessed. If the quality of the DNA can be maintained, these products have the potential to reduce the ever increasing sample storage costs that forensic biology laboratories face. Work is also being performed to develop preservatives for DNA sample storage as an alternative to those in commercially available products.

Solutions for difficult samples are also being investigated, with work assessing DNA recovery from aged and decomposed samples treated with dimethyl sulfoxide (DMSO) preservative and processed using direct PCR. Possible methods for the differentiation of blood and decomposition fluid are also being investigated, as well as valuable information collected from simulated mass-grave sites measuring moisture and temperature and their potential effect on subsequent DNA analysis. The potential for a biobank of human tissues samples is

also being considered, with a view to provide a resource of pristine and degraded samples for future research and validation.

## ALTERNATIVE DNA ANALYSIS TECHNIQUES

Alternative DNA analysis techniques continue to be developed, including investigation into a Y-STR ancestry typing assay and the potential applications of direct PCR protocols for multiple substrates to detect touch DNA. Low copy number (LCN) analysis remains a priority for some forensic biology laboratories investigating an elevated PCR cycle protocol for the Identifiler® Plus and NGM Detect™ STR profiling kits. Alongside this investigation, consideration of alternative DNA analysis enhancement techniques such as post-PCR clean-up protocols and increased CE injection time is also in progress.

The application of rapid DNA technology continues to be explored by some jurisdictions with the latest instrument available on the market suitable for housing within a police charging station and operation by non-scientific personnel. The purpose of this instrument is to provide real-time intelligence information by reporting links from the National Criminal Investigation DNA Database (NCIDD) while the suspect is still in police custody. Investigation of this instrument is currently being considered from a national perspective by ANZPAA NIFS.

Potential future applications of mitochondrial DNA (mtDNA) testing are also currently being explored, especially for cases where there is only a small amount of DNA or samples are affected by degradation. Active projects include an assessment of the different mtDNA analysis options in use around the world, whole mtDNA genome sequencing in family groups to assess rates of mutation for use in historical cases and the development of a statistical model for the reporting of results from mtDNA analysis. Data is also being collected from Australian volunteers to contribute to the international mitochondrial DNA database (EMPOP).

Species identification for investigation into wildlife smuggling as well as black market and traditional medicine products continue to be developed with the establishment of a dedicated facility underway. This facility will provide a number of services to combat this multi-billion dollar industry, some of which include developing DNA typing methods to link bile to individual bears and horns to individual rhinos.

The use of familial DNA searching continues to be developed intra-jurisdictionally, with the capacity for inter-jurisdictional searching through NCIDD to be made available during 2017, which will operate in accordance with the National Policy for cross-jurisdictional familial DNA searching for the investigation of crime in Australia, developed by ANZPAA NIFS.

## MASSIVELY PARALLEL SEQUENCING

As previously mentioned, the application of MPS technology to forensic DNA analysis is being considered. In 2014, a working group was formed which consists of a representative from each of the forensic DNA analysis laboratories, as well as other laboratories and academic institutions. In addition to assessment and validation projects and engagement in early access trials which assist in the development of new forensic MPS kits, other work includes the development of an open source forensic bioinformatics pipeline for processing of raw MPS files, development of a novel identity SNP panel and development of a suite of phenotype prediction tools for forensic investigators. Population data relevant to the Asia Pacific region is being compiled for current marker panels, while region specific panels for the local market are in development with a focus on representing indigenous populations of both Australia and New Zealand. The establishment of a genetic ancestry genotyping service is underway, as well as work to improve the understanding of legal, ethical and privacy implications of this technology. Currently two forensic biology laboratories have the potential to implement MPS technology in the next 12 – 24 months, if the appropriate population data can be sought and the relevant policy and legislative requirements can be met.

### FORENSIC TECHNOLOGY PROVIDERS

Reponses from forensic technology providers identify advances in rapid DNA and MPS technologies as key areas of focus and they continue to signal their interest in participating in projects that will serve the needs of the forensic biology field in Australia and New Zealand. These include the development of adjustable MPS panels and the use of pyrosequencing for age prediction. They have also indicated their interest in working with forensic science service agencies to provide DNA free consumables certified against the requirements of ISO 18385. In order to meet this standard, the manufacturing process needs to be considered and this has global implications for some of the products that are provided to forensic science service agencies. Products being considered include disposable gloves, plastic ware and evidence collection bags. ANZPAA NIFS will continue to facilitate discussions encouraging the provision of products certified DNA free.

## CHEMICAL CRIMINALISTICS

The area of chemical criminalistics includes a wide variety of examinations based on techniques used in chemical analysis as well as physical comparison methods which rely on the expertise of the practitioners to identify similarities and differences. Given the broad scope of the discipline, there are numerous techniques available for which a forensic application is currently being investigated, including:

- the potential applications of chemometrics to the analysis and interpretation of forensic trace evidence
- the use of Differential Scanning Calorimetry (DSC) for chemical profiling
- the value of micro- and nano- particle populations for the analysis of trace evidence
- the development of extraction and analysis protocols for fibre dyes using Ultra Performance Liquid Chromatography (UPLC)
- the development of Laser Induced Breakdown Spectroscopy (LIBS) analysis and data interpretation for glass analysis and for bullet metal analysis
- the investigation of a simpler Fatty Acid Methyl Esters (FAMES) method for lubricant analysis.

Investigation into trace evidence such as Gun Shot Residue (GSR) continues to be an area of focus with research into potential improvements in the identification of primer and propellant GSR as well as transfer and persistence modelling being conducted by multiple agencies.

The importance of databases for the comparisons performed within chemical criminalistics should not be underestimated, with a large amount of work being performed to compile local relevant databases to support opinions presented in court. An example is the work being performed on fibres, which includes a survey of the types and colours of fibres found on cinema seat tapings at different times of the year. Similar work is being performed to survey vehicle, container and building glass data as well as investigation into the frequency of occurrence of glass samples found on the roadside. The purpose is to assess the potential for glass resulting from innocent events such as broken windows, to complicate the investigation of suspected criminal events such as a hit and run. Paint is another area in which survey data is being collected, including car colours for 2015-2016 and the effects of weather on paint on different surfaces over time. For each of the physical evidence types listed above, methodology is being developed which involves advanced analytical tools to increase the evidential value associated with the results.

The investigation and implementation of standardisation for forensic textile damage examinations is currently underway and included a workshop facilitated by ANZPAA NIFS in 2016 on advanced interpretation of textile damage and an evaluation of the impact of knife blade condition on textile damage. Other areas under investigation include the potential of soil evidence for forensic intelligence gathering, investigation of background solvents in fire debris and investigation into the use of the asphaltene fraction of crude oil for spill source determination. An evaluation of the chemical and physical characteristics of duct tape samples available within a given area is also being performed to provide data for casework interpretation.

A number of agencies continue to develop their capacity to respond to explosives-related incidents with initiatives investigating novel approaches to explosives recovery, storage and analysis. The use of surface ionization techniques for the detection of explosives is being investigated, with the aim being to reduce the complexity and time taken to detect and identify explosives, especially propellants.

Portable instruments suitable for at-scene analysis continue to be developed by forensic technology providers and an evaluation of a portable Gas Chromatography – Mass Spectrometry (GC-MS) for the analysis of air and water samples at fire scenes for hazardous substances is currently being performed. Investigation into suitable instrumentation in shipboard/maritime environments for the generation of forensic intelligence data is also ongoing.

## CRIME SCENE AND BALLISTICS

The field of crime scene investigation is essential to the other forensic science disciplines, as appropriate sample collection is imperative to ensure forensic practitioners have adequate evidence to analyse. As a result, there are a number of initiatives underway that have originated from policing agencies but aim to provide information to the broader forensic science community. An example of this is work being performed to support the medical sciences, with testing of the observable physical changes in the putrification of human remains in the Sydney region, and determination of insect succession in the dry tropical climate of north Queensland to assist in post-mortem interval estimates. For the physical fit aspect of chemical criminalistics, investigation into the most effective method for the removal of tape including a potential substitute for Asahiklin AK-225 fluorinated solvent is being considered. The detection of illicit drugs remains a priority, with a comparative study of the Duquenois-Levine Reagent test and the DrugWipe® test for the presence of Tetrahydrocannabinol (THC) on surfaces as a result of transfer from Cannabis currently underway. There is also an investigation into the ability to match heat sealers to seals, given the notable increase in their use in drug packaging. While examinations are routinely performed, there is limited information available about the variability between sealers to support the results presented in court. Crime scene process modelling initiatives are ongoing, with contamination minimisation continuing to be an important area of investigation. Within the Crime Scene and Ballistics Specialist Advisory Group, there are three scientific working groups and for convenience the remaining initiatives have been grouped accordingly.

### SHOE AND TYRE MARKS

Current initiatives in the comparison of shoe marks are focussing on the development of methods for digital shoeprint comparisons. There is also an investigation occurring into a new technique to compare 3D foot impressions utilising an optical 3D footbed scanner. The impacts of environmental factors also continue to be assessed with a comparison of shoe sole impression lifting mediums at high temperatures:

- gelatin lifting technique
- vinyl static sling film from Penstick®
- footprint adhesive residue lifter from Sirchie®.

### FIREARMS AND TOOLMARKS

In an effort to trace firearms, current initiatives include restoration of obliterated serial numbers using liquid dye penetrants and development of an in-house gun blue formulation. The potential effect of de-calcification chemicals and formalin on fired bullet striae is being investigated as well as the ability to recover DNA from fired and unfired cartridge cases in an effort to extend the potential examination possibilities for recovered exhibits.

### BLOODSTAIN PATTERN ANALYSIS

The detection of blood at a crime scene is an important factor in the re-creation of potential events leading to the blood deposition and for subsequent DNA analysis. Initiatives designed to further develop the understanding of the impact dynamics of blood are ongoing, in an effort to strengthen the science underpinning the interpretation of bloodstains. While visual identification is often possible, chemical enhancement may be required where there is a small amount of blood or where there has been an effort to conceal a bloodletting event. Examples of current initiatives include:

- validation of a new formulation of luminol with increased shelf-life
- investigation into increasing the fluorescence of blood detection tests
- identification of new methods of blood detection for dark surfaces and fabrics
- comparison of luminol and Bluestar® Forensic Magnum for blood detection on laundered clothing
- investigation into the effects of pH on Leuco Crystal Violet (LCV) enhanced bloodstains.

The importance of expertise in bloodstain pattern analysis continues to be investigated including an assessment into how experience levels affect accurate interpretation of blood patterns as well as determination of error rates. Specific expertise in the analysis of cranial gunshot blood splatter and blood on clothing continues to be developed as well as methods to address the potential impacts of human bias in the analysis and reporting of results. Consideration of the subsequent DNA analysis process is also occurring with a project investigating DNA recovery from the buffer solution of ABAcard® Hematrace® kits, used to identify blood at crime scenes and within forensic biology laboratories.

## DOCUMENT EXAMINATION

Method and skill validation continues to be a focus for document examination practitioners across Australia and New Zealand with the method document produced by the Document Examination Specialist Advisory Group (DocSAG) published in an international journal with considerable interest from around the world. Handwriting and signature validation projects are ongoing, as well as an ESDA collaborative validation trial, all of which involve agencies from across Australia and New Zealand and are facilitated with the assistance of ANZPAA NIFS. Other projects currently in progress include:

- investigation into paper for forensic and conservation chemistry
- the use of chemometrics for identification of fraudulent documents
- examination of the homogeneity of document papers when using high-end analytical techniques such as Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS).

## ELECTRONIC EVIDENCE

The area of electronic evidence is a fast developing field due to the rapid advancement of technology in recent years. The introduction of new technology means that fast and effective validation of methods is a priority, and the proliferation of digital capture devices in the community means that the source of information for analysis can be varied. The arrival of 3D printing also has the potential to significantly impact the electronic evidence field with capabilities increasing at a considerable rate. Where possible, the initiatives identified within this field have been separated in accordance with the three scientific working groups that make up the Electronic Evidence Specialist Advisory Group (EESAG).

### DIGITAL IMAGING

Developments in 3D capture technology are shaping the current initiatives in digital imaging with work being performed to further develop 3D scene and exhibit visualisation to create a virtual reconstruction of a crime scene. This has the potential to not only provide an opportunity to revisit the scene when required, but also to present evidence in court in context for the jury to consider. It also provides opportunity to include the results of other forensic analyses embedded within the crime scene reconstruction. Further developments in digital imaging include:

- automated scale detection and resizing of images
- the development of algorithms to perform comparisons between images
- applications for photogrammetry software used with remotely piloted aircraft to map large areas accurately.

### COMPUTER FORENSICS

With the speed at which technology is advancing, the ability to store the amount of data which can now be collected is an ongoing issue for the area of computer forensics. Referred to as big data storage, options such as the use of cloud based technology are currently being investigated. The recovery of data is also a priority with the development of new devices resulting in the need for new techniques. Examples include data recovery from:

- vehicle infotainment systems
- devices with increasingly complex password protection
- chips within devices without accessing the operating system.

The applications of automation are also being considered in an effort to mine big data and identify information that is operationally relevant.

### AUDIOVISUAL

Closed Circuit Television (CCTV) cameras are a key area of audiovisual analysis and current initiatives underway to expand current capabilities include:

- development of analytical techniques to enable measurements and reconstructions from CCTV footage
- investigation into the ability to determine the speed of vehicles captured by CCTV footage
- recovery of data from systems which have been damaged or are problematic.

### OTHER

A developing area, in which forensic practitioners are becoming involved, is that of facial identification. This can be divided into two broad categories:

- automated facial recognition systems
- expert practitioner assessment of suspected matches.

Work is currently being performed to assess the accuracy and reliability of the automated systems including the effects of ageing on detecting a match, as well as the development of expertise for practitioners through the development of the facial identification working group, facilitated by ANZPAA NIFS.

## FINGERPRINTS

The forensic intelligence application of fingerprint comparisons is a current area of focus with the use of lights out reporting being trialled. This system uses a fully automated process without the need for human interaction to report potential matches for intelligence purposes. This is occurring alongside initiatives to validate the skills and methods used by fingerprints examiners. New enhancement and detection methods are also being investigated and include:

- use of hyperspectral imaging, anti-stokes luminescence and an anti-body based approach for bank notes
- alternative methods for the application of indanedione-zinc for fingermark detection on paper
- immunogenic impregnated lifting devices for use on difficult surfaces
- infra-red fluorescent powder from Foster and Freeman
- glacial acetic acid on thermal paper
- use of silica nanoparticles
- thenoil europium khelate
- use of Oil Red O.

Fundamental studies into the chemical and physical properties of latent fingermarks are ongoing as well as the use of automated friction ridge detection and resizing software. A statistical model for the reporting of fingerprint results is being investigated, as well as the potential implications of glove impressions and impressions from non-human animals including primates. Given the increasing importance placed on contamination minimisation measures, there are also initiatives related to the cleaning of fingerprint brushes.

## ILLICIT DRUGS

A recent scan of crime statistics and policing priorities released by ANZPAA NIFS highlighted that the highest number of recorded offences in Australia are associated with illicit drugs[1]. As a result, a number of the initiatives currently underway relate to the improved detection of illicit drugs through rapid and in-field analysis. Examples of initiatives related to the rapid detection of illicit drugs include the development of new chemical screening tests, including for new psychoactive substances (NPS), and participation in the CSIRO CYBERNOSE® initiative. Hand-held technologies also offer opportunities for more comprehensive in-field analysis and current initiatives include assessments of TruNarc™, portable Raman and portable Infrared (IR) devices. The applications of wastewater analysis continue to be developed and include:

- analysis and monitoring of community illicit drug consumption
- investigation into the potential identification of clandestine laboratory activity
- investigation into the ratio of waste vs product produced from a methylamphetamine manufacture
- investigation into the rate of reaction and impurities formed during methylamphetamine manufacture.

The applications of forensic drug intelligence continue to be developed with initiatives relating to drug profiling and the use of stable isotope techniques for drug intelligence, as well as expanding the use of physical characteristics of illicit drugs as a tool for intelligence-led policing. Other chemistry techniques currently under investigation include:

- the use of molecularly imprinted polymers for drug detection
- potential forensic applications of Direct Sample Analysis – Time of Flight (DSA-TOF)
- expanding applications of Liquid Chromatography – Mass Spectrometry (LCMS), including building capability for the analysis of peptides

[1] De Grazia, Adrian. 2016. *Current and Emerging Issues in Forensic Science Service Provision.* ANZPAA NIFS. http://www.anzpaa.org.au/forensic-science/our-work/products/publications.

- examining the production of methamphetamine from ephedrine and pseudoephedrine to support illicit drug profiling and clandestine laboratory investigation
- identifying new methods for the production of Amphetamine Type Stimulants (ATS) and NPS to provide evidence to support regulation of new precursors and drugs
- clandestine drug manufacture:
  - akabori-momotani synthesis of ephedrine analogues
  - bayer-villiger synthesis in the manufacture of P2P analogues
  - phenylalanine to amphetamine
  - phenylpropandione drug syntheses
  - pseudonitrosite route to amphetamines
  - manganese dioxide oxidation of toluene to benzaldehyde.

Capacity building initiatives within forensic chemistry laboratories are also ongoing with the implementation of robotic instrumentation and investigation into the incorporation of Raman spectroscopy into work units to detect LSD and NPS.

## MEDICAL SCIENCES

Although the field of medical science has a long history, the underpinning science behind some of the techniques with a forensic application is facing increased scrutiny in court. These techniques can provide valuable information to a criminal investigation and practitioners are working to ensure that fundamental forensic requirements are met to ensure they are fit for purpose.

In the field of forensic pathology, there are a number of projects underway which attempt to identify best practice and inform evidence based opinions. These include a longitudinal study of coronial case types over a ten year period and a statistical comparison of genital injuries in sexual assault complainants and offenders. Current case studies include investigation into vertebral artery trauma and air embolisms in post-mortem CT scans. A new technique polarising amyloid deposition under Haematoxylin and Eosin (H&E) staining is also being investigated as well as Massively Parallel Sequencing (MPS) applications for the detection of mutations in genes known to cause cardiac conditions.

A significant development in the field of forensic anthropology in Australia has been the establishment of the Australian Facility for Taphonomic Experimental Research (AFTER) which will collect data from single and mass graves over the next three years. This data will be a valuable resource for forensic practitioners from all of the medical science fields and will provide region-specific data which anthropologists can use in their interpretation of skeletal remains. Other initiatives underway include:

- testing methods for separating commingled remains
- compiling Victorian population specific anthropological data
- the use of imaging to distinguish between human and non-human bones
- improving methods of estimating time since death of human skeletal remains.

The field of forensic odontology continues to investigate techniques that can improve the recording and identification of dentitions, including the use of 3D superimposition for the surface of teeth and determination of the reliability and validity of a portable 3D oral scanner. Investigation into craniofacial ID and age estimation of children is ongoing, as well as the development of an index that can quantify the degree of similarity between a post-mortem and corresponding ante-mortem dental radiograph. Work is also being performed to assess time since death and age of teeth using amino acid racemization.

# TOXICOLOGY

A key focus of forensic toxicology laboratories is the development of standardised training and processes as well as effective information sharing mechanisms between the different service providers. The continuing evolution of New Psychoactive Substances (NPS) presents an issue for toxicological screening, with initiatives for enhanced sample preparation and analytical methodology currently being investigated as well as the synthesis of human metabolites of Amphetamine Type Stimulants (ATS) and NPS, to act as qualitative and quantitative reference materials. The use of surface mass spectrometry for the detection of drugs in saliva is currently being investigated, as well as new approaches to speed up the process of extracting drugs from hair and a method to extract histamines and metabolites from whole blood. An evaluation of the NarcoSpray® drug detection spray is underway as well as the development of methods for the characterisation and analysis of synthetic cannabinoids.

In order to assist in the determination of cause of death, an assessment of which drugs are prone to rise or fall in post mortem specimens is underway, as well as an investigation into the effect of decomposition on the level of β-phenylethylamine in post-mortem blood. Objective methods for the detection and ageing of bruising using non-invasive spectrometric techniques are in development, as well as an investigation into whether there is sufficient penetration of carbon monoxide through skin to influence carboxyhaemoglobin levels in post mortem blood. Current case studies include the impact of a synthetic cannabinoid (AB-CHMNINACA) on the ability to drive a motor vehicle, investigation into a series of deaths related to pentobarbitone and a five year review of cases in which NPS were identified in blood specimens taken from drivers.

# OTHER

## NUCLEAR FORENSICS

The application of nuclear forensics is generally related to national security and has limited implications for community policing. As a result, only a small number of agencies are involved in research and innovation initiatives in this space. Current initiatives include:

- development of methodology to identify the source of uranium-containing material
- exploitation of fingerprint and DNA evidence contaminated with radionuclides
- investigation into the effect of irradiation on explosives in soil.

## SOCIAL SCIENCE

Social science considerations and their impact on forensic science continue to be investigated, with numerous initiatives assessing the fundamental principles and value of forensic science techniques, often considered unassailable in the past. A large proportion of the work relates to acknowledging and reducing the impact of human bias factors, especially where the human expert is the instrument, as well as identifying pattern and impression expertise. This is also relevant to the peer review process and initiatives to investigate the requirements of a robust peer review process are ongoing. Work to improve the presentation and understanding of forensic evidence in court is also ongoing, as well as the development of ethics training programs for forensic practitioners. The difficulty in assessing the effectiveness of forensic science in economic terms is also being addressed with the development of methodology to accurately measure and assess the appropriate metrics. Forensic science service providers also continue to implement business improvements through information technology solutions as well as the application of lean six sigma methodology.

# CURRENT PARTNERSHIPS

The ANZPAA NIFS R&I Strategy and Roadmap Project Survey was disseminated to all government forensic science service providers, numerous academic institutions and multiple commercial providers of forensic products. Almost all of the organisations that responded acknowledged valuable relationships with equivalent agencies in other jurisdictions. There were also a number of responses from forensic science service providers which highlighted the importance of relationships with academic institutions. Given the number of survey responses received, relationships between different government departments involved in the criminal justice system, policing agencies and academic institutions across Australia and New Zealand have not been listed; rather, some examples of international partners and those not traditionally associated with forensic science are listed below:

- Australian Defence Force (ADF)
- Australian Tax Office (ATO)
- Beijing Genomic Institute
- Bureau of Crime Statistics and Research (BOCSAR)
- Combatting Terrorism Technical Support Office (CTTO)
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Environment Protection Agency (EPA)
- Indiana University – Purdue University Indianapolis
- Indianapolis Museum of Art
- King Saud University
- Ludwig Boltzmann Institute for Clinical Forensic Imaging
- National Museum of Australia
- Oceania University of Medicine
- Queensland Institute of Medical Research (QIMR) Berghoffer
- Royal Canadian Mounted Police
- Sam Houston State University
- TRACE – The Wildlife Forensics Network
- TRAFFIC – The Wildlife Trade Monitoring Network
- United States:
  - Defense Forensic Science Center (DFSC)
  - Department of State
  - International Technology Center-Pacific (ITC-PAC)
  - National Forensic Science Technology Center (NFSTC)
  - Navy and Marine Corps
- University of Antwerp
- University of California Irvine
- University of Dundee

- University of Lausanne
- University of Leicester – Interdisciplinary Training and Research Programme for Innovative Doctorates in Forensic Science (INTREPID)
- University of Santiago de Compostela
- University of Strathclyde
- University of Texas
- Zoos SA

# CONCLUSION

The positive response from the overwhelming majority of the forensic science community to the ANZPAA NIFS R&I Strategy and Roadmap Survey, as well as the significant number of initiatives contained in this report, demonstrate that there is a strong foundation on which to build the R&I Roadmap. The survey process did identify some overlap in the work being performed by different agencies, however, it is anticipated that an R&I Strategy which encourages a co-ordinated and collaborative approach will work towards reducing duplication in the future. It has been acknowledged that forensic science as a whole lacks a strong research culture[2], and this was supported by the lack of initiatives, or in some cases, lack of response from some agencies as well as the reassertion of the roadblocks already reported by ANZPAA NIFS[3]. However, it is anticipated that ANZPAA NIFS is now well placed to promote and encourage research initiatives through the development of the Strategy and Roadmap that will build on the work contained in this document and strengthen forensic science towards 2030.

[2] Mnookin, Jennifer L., Simon A. Cole, Itiel E. Dror, Barry A. J. Fisher, Max M. Houck, Keith Inman, David H. Kaye, Jonathan J. Koehler, Glenn Langenburg, D. Michael Risinger, Norah Rudin, Jay Siegel, and David A. Stoney. 2011. The Need for a Research Culture in the Forensic Sciences. *Faculty Working Papers.* UCLA School of Law. Paper 26.

[3] ANZPAA NIFS Innovation (R&D) Strategy identified the top three R&I roadblocks as lack of funding, limited amount of time and limited research experience (2012).

# ACKNOWLEDGEMENTS

The ANZPAA NIFS team would like to thank the following organisations for providing responses to the ANZPAA NIFS R&I Strategy and Roadmap Project Survey:

- Australian Federal Police
- Australian Nuclear Science and Technology Organisation
- ChemCentre, Western Australia
- Curtin University
- Flinders University
- Forensic and Analytical Science Service, New South Wales Health Pathology
- Forensic and Scientific Services, Queensland Department of Health
- Forensic Science South Australia
- Forensic Science Service Tasmania
- Griffith University
- Institute of Environmental Science and Research, New Zealand
- IntegenX
- NetBio
- New South Wales Police
- New Zealand Police
- Northern Territory Police
- PathWest, Western Australia
- QIAGEN
- Queensland Police
- South Australia Police
- Tasmania Police
- Thermo Fisher Scientific
- University of Canberra
- University of Tasmania
- University of Technology Sydney
- Victoria Police
- Victorian Institute of Forensic Medicine
- Western Australia Police
- Western Sydney University



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