

# POLICE FORENSICS REPORT

2023

# FOREWORD

As we stand at the brink of a new era in policing, it is important to take stock of the challenges and opportunities that lie ahead.

**“The world is changing rapidly, and law enforcement must adapt to new realities and technologies if it is to effectively protect and serve the public.”**

This report offers a comprehensive look at the future of policing, exploring trends and innovations that will shape the field in the years to come.

It is my hope that this report will inspire meaningful discussion and reflection among those who are committed to making our communities safer and more equitable. Whether you are a law enforcement professional, a policy maker, or simply a concerned citizen, this report provides valuable insight for the future of policing, with particular emphasis on the pivotal role of forensics in law enforcement.

The World Police Summit is a leading forum for global police and security experts. It

offers an inspiring opportunity to promote better policing and explore, discover, and share the latest developments in the field. With six distinct conferences covering Crime Prevention, Forensic science, Anti-Narcotics, Police Innovation and Resilience, Drones, and K9, the Summit offers a chance to learn best practices from the front line and meet the sector leaders shaping next-generation policing.

As we embark on this exciting journey, let us remain steadfast in our commitment to justice and the principles of fairness, equality, and respect for all. The future of policing holds great promise and with the right leadership, collaboration, and vision, we can create a law enforcement system that is just, effective, and trusted by all.

**H.E. LT. GEN. ABDULLA KHALIFA AL MARRI**

**Commander-in-Chief**





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# EXECUTIVE SUMMARY

The use of forensic science techniques has traditionally been concentrated on more serious crimes such as rape and homicide. Increasingly, however, forensic techniques are being used routinely to aid the investigation of volume crimes such as burglary and vehicle crime. This paper aims to draw together global social research on the application of forensic techniques to volume crime investigations. The main objectives of the review were to identify:

- The mechanisms by which forensic science is applied to the investigation of crime
- The strengths and weaknesses of the use of forensics in the investigation of crime

- The way in which forensic science contributes to the effective and efficient detection (and conviction) of crime

-The future of forensic science and emerging technologies

As technology infiltrates every aspect of our lives, it is no wonder that solving crimes has become almost futuristic in its advances. From retinal scanning to trace evidence chemistry, forensic technologies are becoming increasingly advanced.

This field is one of the fastest growing in the world. One way to measure this is in the increased demand for forensic science technicians.

According to the Bureau of Labor Statistics (BLS 2022), there will be an 11% increase in jobs for forensic science technicians nationally between 2021 and 2031. The BLS indicates that this growth is due to new forensic science techniques that have increased the availability and reliability of objective forensic information. Courts and law enforcement agencies need to hire additional staff to use these techniques to analyze data for use in trials.

The problems in forensic science typically tend to contribute to many wrongful convictions at times. The crisis in forensic science is a complex global challenge which brings an impact on the criminal justice system. The methods which are involved and handled at times result in wrongful convictions. Quality standards for forensic evidence

are sometimes inconsistent, which can lead to discrepancies while drawing conclusions. The problem arises mainly because of investigators' reckless negligence, including forensic experts and police officials. The main challenges that influence the criminal justice system are unreliability or invalidity of forensic discipline, insufficient validation of a method and misleading testimony.

# INTRODUCTION AND OVERVIEW

## 1. About Forensic Science

Forensic science is the use of scientific methods or expertise to investigate crimes or examine evidence that might be presented in a court of law. It comprises a diverse array of disciplines, from fingerprint and DNA analysis to anthropology and wildlife forensics. Though they represent varied disciplines, all forensic scientists face a common set of challenges: ensuring that forensic methods produce reliable results, communicating accurate and understandable findings to a jury or other non-experts, and keeping up with new technology without falling behind on casework. The field of forensic science covers:

- Document examination
- DNA analysis
- Electronic/digital media
- Fingerprinting
- Autopsy techniques
- Engineering
- Linguistics
- Anthropology
- Pathology
- Economics
- Accounting
- Entomology
- Toxicology

The traditional disciplines of forensic science include:

- Toxicology (the study of alcohol and drugs)
- Serology (the study of blood and other biological fluids)
- Questioned document examination (handwriting comparison, study of inks, typewriter imprints, counterfeiting etc.)
- Chemistry

- Firearms identification and ballistics (the study of marks and striations on bullets)
- Hair and fiber analysis
- Pathology
- Odontology (the study of bite marks, teeth structure)
- Anthropology and the determination of a biological profile

Other specialties include, but are not limited to, the following:

- Disaster identification (e.g., identifying bodies and cause of death)
- Analysis of lip prints (Cheiloscopy)
- Meteorology (the impact of weather on a case)
- Bloodstain pattern identification
- Voice print analysis
- Geology
- Botany
- Nursing
- Psychiatry and behavioral science
- Biometrics
- Entomology
- Taphonomy

## 2. THE ROLE OF FORENSIC SCIENCE IN CRIME DETECTION

Forensic science has become an essential part of the judicial system. It has a highly critical but often underrated role.

From fingerprints and blood splatter to DNA samples and injuries—everything at a crime scene tells a story, and it is forensic science that enables this story to be heard.

Forensic science may prove the existence of a crime, the perpetrator of a crime, or a connection to the crime through the examination of physical evidence, administration of tests, interpretation of data, clear and concise reporting, and truthful testimony of a forensic scientist. It answers the “who, what, when, where, and how” questions pertaining to the crime that was committed. It can be used by the prosecution to prove the guilt of the accused beyond a reasonable doubt on one hand and can also be relied upon by the defense to prove innocence on the other. When it comes to level of investigation, no matter the severity of the case, nothing can prove more beneficial to the crime investigator than the use and implementation of the principles of forensic science. The results of those forensic investigations can mark the difference between the acquittal and conviction in the court of law.

Forensic science can assist criminal investigation by helping interrogate suspects, victims and witnesses to get to the truth. Neurological tests, hypnosis, psychological detection of deception (lie detection), narco-analysis and brain mapping have revolutionized police investigation, saving time, money and effort, and providing superior results. These scientific methods have also made interrogations more humane and legal, thereby eliminating notorious third-degree methods of which most often prove disastrous.

Criminal investigation is a pragmatic science that comprises the study of facts used to categorize, uncover, and demonstrate the culpability of an accused criminal. A comprehensive criminal investigation can include probing, consultations, cross-examinations, evidence collection, preservation, and various methods of investigation.

# FUTURE OF FORENSIC SCIENCE

Forensic science has a promising future as new methods, technologies, and scientific advancements create new possibilities that have not yet been imagined. For example, while the discovery and utilization of DNA has transformed current-day forensic science, it will continue to do so as the detection technologies develop and our understanding of trace DNA transfer, persistence, prevalence, and recovery grows. New discoveries can create incremental evolutionary changes or revolutionary changes that will reshape the face of forensic science all together.

This futuristic view considers that one of the most critical, challenging, and foundational aspects of forensic science is that it is a complex interdisciplinary field, with multiple stakeholders, drivers, and pressures. For this reason, the potential of new technologies and an increased evidence base to underpin crime reconstructions is clear.

Forensic science is often driven by specific issues and scandals (such as a miscarriage of justice), and resources are specifically deployed to address them. This means that forensic science is often reactive to symptoms that arise, rather than engaging in continuous and systematic proactive examination, research, and self-reflection as routine practice. In addition, forensic science frequently works within the framework that every case is different, which creates a fundamental tension between research seeking to develop generalizable theories and approaches, and professional practices in crime reconstruction. Therefore, a long-term view of the possibilities

and potentially desirable directions of the future of forensic science is an important undertaking.

As we consider a vision of the future, one of the basic challenges is that some forensic domains have developed within investigative practices rather than first establishing the principles and foundations of a domain through scientific research. This has also led to many forensic domains having small amounts of data. Courts have readily accepted forensic science evidence and given the complex ecosystem of forensic science with many interacting variables, the courts have allowed forensic science to flourish even without a truly holistic and coherent overview of crime reconstruction approaches, and a scientific research culture.

Timescale is a critical variable, because the further into the future we go, the more unknown and unpredictable factors there will be. However, it is possible to predict that forensic science in the future will take advantage of the development and utilization of emerging technologies, which will create new capacities to capture, produce, store, search, synthesize, visualize, and interrogate data. It is also clear that with all these new and exciting possibilities, new challenges and vulnerabilities also arise.

## FUTURE TRENDS IN FORENSIC SCIENCE

### GROWTH

One of the clearest and most important trends in forensics is its remarkable growth over the past 15 years. At the Netherlands Forensic Institute (NFI), the number of cases handled per year is now six times what it was in 2000. In fact, the caseload has grown more in the past 15 years than in the previous 50. In the same period, the NFI's workforce has nearly tripled, growing from about 200 to 600 people. This is clearly part of a larger trend, with caseloads growing steadily at forensic laboratories around the world. Although the recent budget cuts and the economic downturn may temporarily slow the growth of the forensic sector, the fundamental drivers of change persist and will continue to assert themselves.

The growth in forensics has been driven by three main factors:

- The introduction of new technological capabilities
- Increased general awareness among customers on the value and efficiency of forensic science
- The advent of new types of customers from outside the scope of traditional forensics

## 1. NEW TECHNOLOGICAL CAPABILITIES

Much of the recent growth in forensics has resulted from the introduction of new technologies. Most notably, high-tech biometrics (predominantly forensic DNA), forensic information technology (IT), and forensic chemistry. Just twenty years ago, the first two of these disciplines were not practiced at the NFI. Today, they are the largest and fastest growing disciplines at the Institute. It is not surprising that these new technologies lead to growth; the pressure to put any new investigative technique into practice when it is first introduced quickly increases. As in other fields like health care, ethical and quality issues may need to be resolved before a new technique can be used. Otherwise, if it provides valuable information, there will be a strong demand for it to be used immediately and on a wide scale. This way, when any new technology or scientific insight creates its own demand, forensic innovations are likely to continue to spur growth in the field.

It is significant that the three disciplines mentioned above (forensic DNA, IT, and chemistry) do not simply add new and refined technological capabilities to the forensics toolbox. They also

address new classes of trace evidence that may not have been previously collected and analyzed. This applies to both biometrics and forensic IT, but forensic IT is particularly significant in this context as it opens a whole new world of trace evidence.

Today, it is almost impossible to prevent leaving digital traces—in cell phones, on computers, on the Internet, in digital surveillance cameras, in an ATM, in a navigation system, in a car's on-board computer, and so on. People have a symbiotic relationship with both the physical and the digital world. This has profound consequences for forensics because everything we do leaves a trace in these worlds. It will therefore become increasingly important that forensic service providers be able to retrieve relevant data from all available digital sources and to analyze these intelligently.

Additional growth is also generated through the continuous improvement of existing technologies. As they become more sensitive, the amount of relevant information that can be retrieved from traces will increase, as will the number of traces that can be analyzed in the first place.

## 2. GREATER AWARENESS OF THE VALUE, EFFICIENCY, AND POTENTIAL OF FORENSICS

Greater awareness of the value, efficiency, and potential of forensics. The use of forensic investigations has increased not only due to the advent of new technologies but also due to an increased awareness of what forensics has to offer. Existing and potential end-users, the press and the public are all more aware today of the extent of forensic capabilities. This, in turn, is generating an increasing demand. Forensic investigation is gradually assuming a more central and high-profile role, and is becoming an essential tool for law enforcement, homeland defense, and others entrusted with maintaining justice, social order, and security. Court cases are increasingly depending on DNA evidence, and security and terrorism threats are being prevented on the basis of digital traces. A wide variety of investigators are also taking an interest in what forensics has to offer them. Historically, forensic science has served primarily as the tool of prosecutors in

preparation for trial, not necessarily as a tool of investigators. With the advent of faster methods and forensic databases (DNA, fingerprints, firearms, etc.) over the past several decades, forensic science is becoming an invaluable tool in criminal investigations and intelligence, even before a suspect has been identified.

As users become more aware of the benefits of the new tools and expertise available, they discover new ways to use forensic science. For example, the police are under great pressure to apprehend criminals while at the same time ruling out innocent civilians as suspects. Forensics can help them meet that need by providing reliable information through technical means without harassing innocent citizens. This increased awareness of what advanced forensics has to offer is leading to increased demand on the part of traditional customers of forensics laboratories.

## 3. NEW CUSTOMERS AND CUSTOMER FOCUS

The capabilities of forensic service providers have not passed unnoticed in domains outside of criminal justice and law enforcement. In fact, a wide range of governmental

organizations—involved in everything from defense and intelligence to administrative law and regulatory oversight—are using forensics in their investigations. This new demand for

forensic science is a main driver of growth in the sector. Nevertheless, not many traditional crime labs are taking advantage of this fact. Of course, new customers have different needs from those within the criminal justice system (police, prosecutors, and the judiciary). For example, the type of information required and the balance between speed and accuracy may be quite different. Accordingly, in recent years, many of these organizations have created their own specialized forensic units and, in some organizations, their own databases. However, these units are often small and somewhat disconnected from the wider forensic community. This has increased the fragmentation of the forensics sector as a whole and has occasionally resulted in some organizations reinventing the wheel. Nonetheless, these changes also represent an opportunity for the forensic sector. Serving a broader customer base not only reduces but can also give rise to improved services at lower costs through economies of scale.

The atypical requirements of new types of customers stimulate innovation and drive the development of new knowledge, which will ultimately benefit all customers. As a result of these shifts, a new role for the forensic community is emerging. It no longer solely provides forensic services in the fields of law enforcement and criminal justice. Forensic institutes become first and foremost high-tech knowledge hubs, filled with knowledge workers who deliver their services to the (mostly government) agencies that may require these and who enrich the hub in the process.

At the NFI, this process could be observed at first hand by serving non-traditional customers in 17 countries inside and outside the Netherlands. The organization has acquired capabilities and experience that it would not otherwise have been able to obtain, and that are now also available to traditional customers. As knowledge hubs, forensic institutes become more valuable if they enlarge the network to which they belong and in which they operate. Non-traditional customers include ministries of defense, municipalities, intelligence agencies, benefit and tax fraud investigators, the financial market regulator, transport safety boards, competition authorities, and international bodies, such as the international tribunals and criminal courts, but also Europol, Interpol, the IAEA, and the United Nations.

The current heightened awareness of forensic science and recognition of its value means customers are making greater use of forensics and placing greater reliance on it. In short, forensics has moved from occupying a supportive—almost behind the scenes—role to becoming a key protagonist. It has become mission critical for many users and, as a result, customer demand is increasing. Customers are subjecting closer scrutiny to what they receive from their suppliers, requiring more attention from suppliers to identifying their customers'

primary needs. Forensic laboratories can also supply customers with value-added information, specifically on past events and behaviors and the individuals involved in these events. This information is obtained from the traces that resulted from these events and behaviors. All customers want the supplier laboratory to provide as much relevant information from available traces as possible, and they want the information to be reliable and objective.

They do not want the information to depend on the forensic investigator handling the case; and, if necessary, they want the forensic investigators to be able to show a solid scientific basis for their conclusions. Customers also want the laboratory to be able to handle as many trace investigations as possible, because a larger number of trace investigations generally yields more information. It also reduces the risk, down the line, that police investigators or prosecutors will be criticized for failing to order trace investigations that are potentially exculpatory, or for failing to do everything possible to apprehend the criminals.

When forensic laboratories have a fixed budget, the drive to increase the total output of the laboratory implies that the average cost per investigation must be reduced. To most customers of forensic laboratories, receiving the results of the forensic investigation as quickly as possible is extremely important. This is especially true in the intelligence gathering and investigation phases when time is of the essence. After a crime has been committed, the first 48 hours are often critical in the investigation. In the intelligence phase, being able to analyze traces quickly and reliably can mean the difference between being able to prevent a crime (such as a terrorist attack) or not. The value and impact of forensics increase greatly when results can be delivered quickly.

In other words, the primary needs of the customer can be summarized as follows: more, better, faster, and cheaper. The forensic community however has historically paid less attention to these needs. It focused on the technical content of the forensic trades and the individual skills of the practitioners. In most cases, the costs of individual forensic investigations are not considered at all, either directly or indirectly. Many forensic investigators, laboratory directors, and even customers resist the idea that costs should play a role in decision-making before committing to forensic investigations.

The implicit belief seems to be that one cannot and should not let financial considerations play a key role when important societal issues (such as apprehending a criminal and dispensing justice) are at stake. Nevertheless, since open-ended financial arrangements are an illusion, the practical results of this way of thinking are backlogs, stagnation, and

a far from optimal—even unknowing—allocation of scarce resources. All this is changing, however, and will continue to change due to the increasing reliance on forensic investigations and the pressure this puts on forensic laboratories.

The same can be said about the drive to increase

the information value extracted from traces, as well as the scientific basis and objectivity of forensic conclusions. Both require focused and customer-oriented research and development (R&D) partly due to the arts-and-crafts culture of the forensic field.

## DISCLOSURE OF CHILD MALTREATMENT

The future of forensic science is evolving in terms of the disclosure of child maltreatment. This includes:

- The increased use of technology and artificial intelligence (AI) in child protection and support services, enabling early detection and intervention for at-risk children
- A greater focus on trauma-informed care, ensuring that professionals working with children are aware of the potential impact of past trauma on their development and

behavior

- The integration of mental health support services into schools and communities, allowing for more accessible and holistic care for children exposed to abuse
- A growing awareness and emphasis on cultural competence and diversity within child welfare agencies and support services, ensuring that professionals are equipped to work with children from various backgrounds

## THE FUTURE OF DIGITAL FORENSICS

- Increasing reliance on AI and machine learning for digital forensics and incident response
- Expansion of internet of things (IoT) devices, leading to more data sources and evidence for investigators
- Greater emphasis on cross-border collaboration and information sharing among law enforcement agencies
- Rising importance of cloud forensics as more data and services migrate to cloud-based platforms

## NEW COUNTER-DRONE TECHNOLOGY AND FORENSICS IN THE CLOUD

- Increased autonomy: As drone technology advances, we can expect drones to become more autonomous, requiring less human intervention for tasks like navigation and decision-making
- Integration with IoT and AI: Drones will likely be integrated with IoT devices and AI systems, enabling better data collection and analysis, as well as improved decision-making capabilities
- Expanded applications: The use of drones will expand into new industries, such as agriculture, infrastructure maintenance, and emergency response, providing innovative solutions to various challenges
- Enhanced regulations and policies: As drone usage increases, we can expect governments to develop more comprehensive regulations and policies to address potential security, privacy, and safety concerns



## FUTURE FORENSICS TOOLS, TECHNOLOGIES, AND TECHNIQUES

The future of forensics is very promising and there are tools identified that can support these investigations and assist in other forensic domains,

technology advancements, techniques to solve problems and improve processes, and new trends that we will explore further here.

### 1. THE IRPS TOOL

The potential of a tool such as the integrative reconstruction and prediction simulator (IRPS) in the future will be providing indications of the likelihood of the source attribution, as well as the ability to draw conclusions. For example, between primary and secondary transfer of trace DNA, and to give information, such as a facial image, of who committed a crime with a measure of likelihood based on the simulation data produced. However, when the forensic science evidence is not conclusive and several possible scenarios are viable, then non-scientific lines of evidence could be used to further assess the different scenarios, in a way that ensures transparency in terms of what intelligence/evidence was used in computing each possible scenario, which will be routinely recorded and documented. With such future capabilities, forensic science may not only utilize the IRPS to reconstruct and solve crimes, but this kind of IRPS tool will ensure greater transparency in the documentation of how reconstructions were computed during the original analysis. Hence, it will enable better communication and documentation of the decision pathways that resulted in the findings and establishment of the weight of the evidence provided to the fact finders. The futuristic vision of forensic science, along with the developing capabilities of simulation and predictions of tools (IRPS), are expected to play an important role before crimes occur. First, the IRPS can provide intelligence for the disruption and prevention of existing crimes. For example, it may deal with a single crime scene and create a database within the IRPS of all other

crimes—past and present. This would then enable connections and inferences across crime events to be made, regularities and common themes to be found, and intelligence that can be deployed to disrupt and prevent crime produced.

In addition, as society and technological capabilities change, existing crimes will need new forensic tools. For example, changes from paper currency to polymer require new techniques for the development of fingerprints deposited on the new plastic notes. As it becomes possible to capture, retain, store, and search greater amounts of data, a system such as the IRPS would have the capacity to store and use a whole range of data such as the chemicals used in the manufacture of paint and ink, the patterns of different tire treads, and the digital signatures of various devices to enhance evaluative interpretation. The IRPS may also be able to record and make use of artificially modified elements in the production of goods (firearms) so they can be easily traced and identified if used in a crime.

Finally, a further capability of future IRPS forensic science tools will include the identification and anticipation of new forms of crime that are enabled by emerging technologies, such as new digital capabilities, AI, machine learning, remote sensing, robotics, electronic remote control, autonomous vehicles, and drones. These technologies are inevitably benefiting society but will also present opportunities for new types of crime.



## 2. CARBON DOT POWDERS

Fingerprints are essential for analyzing many crime scenes. However, there are many reasons why it may be hard to see one clearly, including low sensitivity, low contrast, or high toxicity. Researchers have developed a fluorescent carbon

dot powder that can be applied to fingerprints, making them fluorescent under UV light and subsequently much easier to analyze. With this new application, fingerprints will glow red, yellow, or orange.

## 3. ARTIFICIAL INTELLIGENCE

While AI has been used in many other fields for decades, it is relatively new to forensic science. This is primarily because all evidence and the analysis must stand up in court. However, recent advancements have seen AI utilized successfully

in all forensic components of a criminal case. While AI is most often used in digital forensics, it is increasingly used to analyze a crime scene, compare fingerprint data, draw conclusions from photograph comparisons, and more.

## 4. NANOTECHNOLOGY

Atomic and molecular technology are finding their way into forensic science. Analyzing forensic materials at this minute level can offer scientists insight that previously weren't accessible. Nano sensors are being utilized to examine the presence of illegal drugs, explosive materials, and

biological agents on the molecular level. Specific advancements this past year have included scientists' ability to analyze the presence of carbon and polymer-based nanomaterials to make their determinations and aid investigators.



## 5. PROTEOMES

Forensic scientists have traditionally relied heavily on DNA to determine a suspect or victim. However, advances in detecting and identifying proteins have made proteomes an essential forensic science tool. Proteomes are a complete set of proteins produced by an organism. Scientists can find proteomes in blood, bones, and other biological materials and analyze them to find answers, such as if a victim met an otherwise

undetectable venom or matching a severely degraded body fluid sample to a perpetrator. One aspect of proteomes that differs from DNA is that they change over time, offering scientists valuable insight into a victim's age or other environmental factors at the time of death that are impossible to detect through other methods.

## 6. FOLDSCOPE

The foldscope is a small, disposable, inexpensive paper microscope that has been around since 2014. However, just recently, it has found its way from third-world country applications into the world of forensic science. Due to its portability and low cost, the foldscope can be used in the field to make on-the-spot determinations about forensic samples, including blood, hair, and soil.

While the conclusions drawn with the foldscope are only preliminary, they can aid law enforcement early on in an investigation and speed up the discovery process. Using a foldscope can also lighten the load for forensic laboratories, which are often backlogged and can take significant time to deliver results.

## 7. DRONES

Adding drone-mounted assistance to ground-based crime scene analysis can help lead better efficiency and speed in analyzing a scene. Unlike ground-based techniques (taking photos, creating maps and charts, sketching, laser scanning) which might contaminate a crime scene because someone must walk through it, drone-mounted technology may eliminate such contamination and the possibility of exposing someone to potential hazards. Researchers at Kansas State University recently tested drone-mounted remote sensors versus terrestrial laser scanning. While terrestrial laser scanning did a better job of creating accurate images of (staged) outdoor crime scenes, when partnered with drone-mounted scanning, the data became even more accurate and less likely to have evidence contamination or destruction.

Using terrestrial scanning methods with drone-mounted motion photogrammetric sensing

and light detection and ranging (LiDAR), the researchers collected both quantitative and qualitative data at staged crime scenes in both daylight and at night. The terrestrial laser scanning took longer and had “blind spots” where scan positions or obstacles blocked a full view. The drone-mounted scans had no blind spots, but sometimes had low levels of distinguishable detail. Reduced detail from both methods occurred under night light conditions.

The research concluded that investigators and juries viewing data from drones could view a crime scene in a more complete and virtually unaltered state. However, the study added that, the better the LiDAR system equipment, the more likely performance would be enhanced in capturing data and images.

## 8. 3D LASER SCANNING

Evidence at a crime scene needs to be documented and there must be reliable data collection to be used in court. Traditional methods of data collection are now being augmented by three-dimensional (3D) laser scanning which produces quality images and precise measurements. Unfortunately, 3D laser scanning is expensive, and you need a well-trained person to do it correctly, but it is superior to the less expensive two-dimensional methods of informing and convincing investigators and juries. Acquiring this technology may be worth considering. To that end, the NIJ supported research at the

University of Tennessee to examine cost/benefit considerations of 3D laser scanning versus traditional crime scene documentation (two-dimensional topographic diagrams, photos and sketches).

While expensive and time-consuming in terms of equipment and user training, the study implied that data from 3D scanners can be accurate and reliable in court and can rank as the preferred method of documentation of different angles at a crime scene, leaving nothing to conjecture.

## 9. DNA FORENSIC LABORATORY EFFICIENCY

A guide to help DNA forensic labs cope with both rising costs and the rising demand for timely and competent analysis. The guide is titled, “National Best Practices for Improving DNA Laboratory Process Efficiency,” and lists 67 recommendations for enhanced lab work.

The recommendations range among topics including improved management and operations; leadership and teams; evidence screening; DNA analysis; case acceptance policies; case prioritization; recruitment, training and retention

of staff; workflow; automation versus bench work; information technology and data management; allele (gene forms and DNA sequences); relevancy of samples; genotyping software; and short and long-term planning for new technologies.

The format features ease of use to focus on five main chapter sections: laboratory management and operations, accepting and managing cases, staffing, data analysis and management, and new technology best practices.

## 10. FIELD DRUG TESTING PROGRAMS

The Forensic Technology Center of Excellence has created a training framework to certify law enforcement officers in presumptively identifying drugs while in the field. In the US, drugs and certain chemicals are classified in one of five schedules, depending on their medical use and their abuse potential. Forensic laboratories confirm these substances after screening with a variety of methods, but recent technology has created screening techniques which use portable instruments for testing in the field.

Pilot programs with the Phoenix (AZ) Police Department, the Utah Bureau of Forensic Services,

the Philadelphia (PA) Police Department and District Attorney, the Oregon State Police, the Ontario (OR) Police Department, and the Michigan State Police tested various commercial drug testing kits to be used in the field and examined the training needed for the proper use of the kits.

Among the results of these pilot programs were conclusions such as keeping testing protocols simple and easy to use, doing annual and even periodic training in correct testing protocols, and collaborating data with prosecuting attorneys and crime laboratories in the jurisdiction.

# CHALLENGES

## 1. UNREALISTIC EXPECTATIONS

The crime scene investigation (CSI) effect is a common lament among police and prosecutors. Popular television shows like CSI and NCIS feature dramatic presentations of forensic analysis as an embedded, coordinated part of criminal investigations. Such a distortion of the structure, capacity, and speed of actual justice system practices creates an unrealistic expectation on the part of citizens generally, and jurors. The CSI effect imputes to the investigative process an impossible scientific basis (miracle science) that cannot be

matched in an unscripted world. The result is a mystical inversion of logic that transforms the absence of evidence into "Evidence!" overall case investigation. Nevertheless, the CSI effect endures. Police officers continue to report citizen expectations of intact fingerprints or useable DNA samples at every burglary scene, and the like. Every introduction of a new technique carries the possibility of raising even greater expectations, even if that technique is not acceptable to the courts.

## 2. EMERGING TECHNOLOGIES

Considerable interest in new techniques of forensic analysis usually dominates the discussion of emerging technology. These are the techniques that hold the promise of advancing the pursuit of justice, bringing the guilty to the bar and exonerating the wrongly accused. However, the future of forensics must also consider new advances in science and technology that make the task of the forensic laboratory even more

complex, expensive, and difficult to explain to courts. The field of forensics does not appear to be prepared for the burgeoning of nanotechnology and molecular assembly, popularly referred to as 3D printing. Among the immediate possibilities and challenges that will inevitably scale up are anonymous 3D printed firearms, designer drugs, designer poisons, and other criminal tools that defeat existing security and defensive techniques.

## 3. THE IMPACT OF DIMINISHED BUDGETS

With the multiple and rapid emergence of forensic examination techniques and equipment, there is a daunting amount of information and material of which to be knowledgeable. For a variety of reasons, investigations training at all levels must

be transformed so that rookie cops and seasoned veterans alike are aware in near real time of new developments, including new evidence possibilities, collection needs, hazards, and limitations.

## 4. UNRELIABLE OR INVALID FORENSIC DISCIPLINE

Studies have demonstrated that some forensic methods used in criminal investigations cannot consistently produce accurate results. Bite mark

comparison is an example of an analysis that is unreliable and inaccurate.

## 5. INSUFFICIENT VALIDATION OF A METHOD

Some of the forensic disciplines in use may be capable of consistently producing accurate results, but there has not been sufficient research to establish validity. Accuracy of a method should be established using large, well-designed studies.

Without these studies, the results of an analysis cannot be interpreted. Analysis of shoeprints as a basis of identifying the unique source of a print is an example of a method that has not been sufficiently validated.

## 6. MISLEADING TESTIMONY

Sometimes forensic testimony overstates or exaggerates the significance of similarities between evidence from a crime scene and evidence from an individual (a suspect or person of interest), or oversimplifies the data. Examples include testimony that suggests a collection of features is unique or overstates how rare or unusual it would be to see these features, implying that it is quite likely that the suspect is the source of the evidence, and testimony that doesn't convey all possible conclusions, as can arise with masking in serology testing. Sometimes forensic

testimony understates, downplays, or omits the significance of an analysis that establishes that an individual should be excluded as a possible suspect. An example is testimony that an analysis is "inconclusive" when in fact, the analysis excluded the suspect.

Sometimes forensic testimony fails to include information on the limitations of the methods used in the analysis, such as the method's error rates and situations in which the method has, and has not, been shown to be valid.



# SOLUTIONS TO COMBAT CHALLENGES

The frequency of forensic investigations has increased due to the advent of new technologies as well as an increased awareness of what forensics has to offer. Each however comes with its own set of challenges, including:

## 7. THE CHALLENGES ASSOCIATED WITH CHILD MALTREATMENT IN THE CONTEXT OF FORENSIC SCIENCE

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Limited resources and funding for child welfare agencies and support services, which may hinder their ability to effectively address and prevent child abuse</li> <li>2. Insufficient training and education for professionals involved in child abuse cases, including law enforcement, educators, and healthcare providers, leading to potential misinterpretation of children's disclosure patterns, or missed opportunities for</li> </ol> | <p>intervention</p> <ol style="list-style-type: none"> <li>3. Stigma and societal misconceptions around child abuse, which can lead to underreporting and a lack of support for victims</li> <li>4. Legal and bureaucratic barriers that may impede the timely investigation and resolution of child abuse cases, potentially leaving children at ongoing risk</li> </ol> |
|--|---|

## 8. THE CHALLENGES ASSOCIATED WITH DIGITAL FORENSICS

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Handling and analyzing the massive volume of data generated by the ever-growing number of connected devices</li> <li>2. Overcoming encryption challenges to access relevant evidence on various devices and platforms</li> </ol> | <ol style="list-style-type: none"> <li>3. Maintaining privacy and data protection regulations while conducting investigations</li> <li>4. Ensuring forensic tools and techniques stay up to date with the latest technological advancements and criminal tactics</li> </ol> |
|--|---|

## 9. THE CHALLENGES OF DRONE TECHNOLOGY IN FORENSIC SCIENCE

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Privacy concerns: The widespread use of drones raises privacy issues, as they can easily capture images and data from public and private spaces without consent</li> <li>2. Airspace management: As drone usage increases, there will be a need for better airspace management to prevent collisions and ensure safe operation</li> </ol> | <ol style="list-style-type: none"> <li>3. Security risks: Drones can be used for malicious purposes, such as espionage or carrying dangerous payloads, posing a threat to national security and public safety</li> <li>4. Technological limitations: Current drone technology has limitations, such as limited battery life and difficulty operating in adverse weather conditions, which restrict their potential applications</li> </ol> |
|---|--|

### 1. SHORTENING DELIVERY TIMES OF CONCLUSIONS

Quick delivery is one of the most important needs that the customers of forensic laboratories articulate. In fact, as forensic investigations are increasingly becoming 'mission critical' to customers, forensic laboratories must reconcile themselves to the fact that the customer if given the choice would like the results immediately. This does not mean that customers in all

circumstances need the results immediately, or that they are always able to act on the information the moment it is provided. However, regardless of how fast investigators are able to act on the laboratory's results, it is a laudable goal for forensic laboratories to reduce the odds of being the choke point in the critical path of criminal investigations.

### 2. LARGER SPACE AND FACILITY

If the forensic laboratory could service a larger geographical area and number of customers, the caseload at a certain point would become sufficient to support a staff with critical mass. If there are ten or twenty qualified forensic examiners in the discipline in question, for instance, one or two of them could be freed up

to conduct research full-time. Furthermore, a larger staff has much more flexibility to deal with setbacks such as illness. In short, the current fragmentation of the forensic sector, with its many relatively small laboratories, is not conducive to R&D and gives rise to problems relating to flexibility and continuity.

### 3. TRAINING AND EDUCATION

As forensic investigations become increasingly important and mission critical to customers, forensic science and technology are becoming

more complicated and difficult to understand for the layman.

### 4. FORENSICS PRODUCTS AND TOOLS

This type of work often leads to specialized high-end products and tools because examiners need them for their cases. This may take the form of both hardware and software. Subsequently, such products and tools can be made available to benefit the forensic community at large. If many integrated forensic institutes around the world

were to do the same, this would create a whole new dynamic in the field. Conversely, if innovative products and tools that require large investments in R&D were distributed free of charge, this would only mean that funds to fuel the innovation engine would become depleted, stopping further innovation in its tracks.



## 5. SOLUTIONS TO COMBAT CHILD MALTREATMENT

1. Strengthening collaboration between various stakeholders, such as schools, law enforcement, healthcare providers, and child welfare agencies, to create a comprehensive, multidisciplinary approach to addressing child abuse
2. Increased investment in R&D of evidence-based practices and interventions for interviewing and supporting children during the disclosure process, in order to minimize suggestibility and false allegations
3. Implementing and promoting preventative programs, such as parenting education and support services, to help reduce the risk of child abuse within families and communities
4. Ongoing education and training for professionals involved in child abuse cases, ensuring they are up to date on the latest research and best practices related to child abuse disclosure and investigation

## 6. SOLUTIONS TO COMBAT DIGITAL FORENSIC CHALLENGES

1. Investing in continuous education, training, and professional development for digital forensic investigators
2. Collaborating with the tech industry to develop advanced forensic tools and techniques to address new challenges
3. Strengthening international cooperation and sharing of best practices among law enforcement agencies
4. Implementing a human-in-the-loop approach where AI assists investigators, but the final decision-making and analysis remain with the human experts

## 7. SOLUTIONS TO COMBAT THE CHALLENGES OF DRONE TECHNOLOGY IN FORENSIC SCIENCE

1. Robust regulatory frameworks: Implementing comprehensive regulations and policies can help address privacy, security, and safety concerns associated with drone usage
2. Counter-drone technology: Investing in counter-drone technology can help detect and mitigate potential threats posed by malicious drone use
3. Airspace management systems: Developing advanced airspace management systems, such as Unmanned Aircraft System Traffic Management (UTM), can help ensure the safe and efficient operation of drones in shared airspace
4. Advancements in drone technology: Fostering innovation in drone technology can help overcome current limitations, such as battery life and weather resilience, expanding their potential applications and benefits



# LOOKING AHEAD

The advent of forensic science has revolutionized the detection of crime. Investigative procedures have seen a change over the course of the past two decades due to the constantly developing technologies used as a part of forensic science. It plays a major role in the justice system as it is majorly due to forensic science that crimes and criminals are identified. As it is a developing study and requires a lot of education, skills as well as experience, the courts have often viewed forensic science as not being enough or completely reliable. Nevertheless, its role in successful convictions cannot be denied.

Forensic science is clearly at an important stage in its development. New advances in technology have placed forensics in an accelerating cycle of growth as more parties realize how useful

forensics can be for their own purposes. However, this popularity—gratifying as it may be—brings its own challenges, as laboratories become bogged down with work and customers become more demanding.

Several years ago, a number of measures have enabled to eliminate backlogs and dramatically improve the quality and delivery times of forensic investigations. In this way, it has been able to markedly improve customer satisfaction and has shown that its integrated model is a viable way forward. The forensic sector has great potential, but it will certainly find itself challenged to live up to the high expectations that customers and society have of it. It is likely that the sector can only succeed if it takes up the challenge and makes fundamental changes where necessary.



## Capt. Abdulla Albastaki

Forensic Biologist  
Dubai Police

### Question 1: What are the various strategic planning techniques for forensic science laboratories?

Answer: Dubai Police's forensics laboratory was built based on benchmarking techniques, recommendations and essential lab equipment and methodologies. Since the building is considered to be new, up-to-date equipment and facilities were brought to add even more to the well-established forensic building. The building as a whole was designed to comply and be in line with international scientific standards, which would help in obtaining international recognitions and accreditations related to the field. Furthermore, a biosafety lab is also about to be established after the pandemic events and was a highlight for Dubai Police.

### Question 2: What are the different ways of enhancing forensic research and developmental skillsets amongst law enforcement agencies?

Answer: To improve our laboratory strategies and keep up with the latest forensic techniques, we rely on the scientific methodologies available, as well as attending conferences to understand and leverage industry best practices. Forensics is a relatively new field among other disciplines and new information and techniques arise on a frequent basis. As each discipline is continuously evolving, some areas, such as forensics, are still being developed and are not fully activated yet. We are therefore committed to exploring and further enhancing forensic research and the learning capabilities within our organization.

### Question 3: What are the main challenges associated with criteria-based content analysis?

Answer: The International Center for Forensic Science, ensures that our experts attend the required training sessions and workshops locally

and internationally, enabling them to tackle any challenges associated with criteria-based analysis. Individuals also get to publish articles, speak at events, and release content.

For instance, Dubai Police has partnered with MicroRead Genetics to develop an innovative DNA kit (called 26 RM Y-plex) that can detect specific genes within the Y-chromosome which pass normally through the paternal lineage. This kind of collaboration will also serve as a great learning tool that could benefit our experts to gain knowledge from private sectors and possibly add value to the field as a whole. All departments in our organization also follow the ISO standard 17025 accreditation which determines the criteria and content to follow while conducting forensic analysis.



## Keith Cottenden

Director of Operations  
3B Data Security

### Question 1: How is the technology revolution contributing to digital forensics?

Answer: The increasing frequency and ever-evolving sophistication of cyberattacks leave digital forensics specialists with masses of data to sort. This data is classified using tools that often struggle to keep up with technology, making it difficult to complete tasks and meet deadlines.

Machine learning is developing through advances in AI to perform meaningful processes and analyse huge amounts of data to discover criminal activity and behaviour. However, there are a few challenges associated with the adoption this technology. For instance, a plethora of devices are now available to store data, making storage options for end-users highly accessible. This is a source of concern because the sheer volume of stored data can overwhelm analysts.

The next challenge is the increasing quantity and complexity of cyberattacks. The tools and methods available to analysts have also not been able to progress at the same rate as these attacks. A good example of how attackers have adapted to the constantly evolving environment is the emergence of distributed systems and abundance of cloud-based services. This also presents a third challenge for forensic specialists as these environments increase the level of intensity of cyberattacks and make it possible for malicious actors to develop even more effective techniques to evade detection.

The priority should therefore be to alleviate some of the workload of cybersecurity staff and digital forensic analysts. Organizations should leverage AI capabilities to handle the depth and complexity of tasks that may be challenging for humans to tackle quickly and accurately. With rapid advances in technology, these applications also need to continuously evolve to address potential threats and detect problems as soon as they arise.

### Question 2: What has been the greatest success of combining digital forensics and incident response?

Answer: The combination of digital forensics and incident response (DFIR) has been highly successful in the field of cybersecurity. DFIR involves collecting and analysing digital evidence to investigate security incidents and breaches, as well as implementing measures to prevent further incidents.

One of the major benefits of DFIR is the ability to quickly detect and respond to security incidents, minimizing the damage caused by cyberattacks. By leveraging digital forensic techniques, incident responders can identify the root-cause of an attack, determine the extent of the damage, and take steps to contain and remediate the threat.

In addition, DFIR can help organizations identify vulnerabilities in their systems and processes and develop strategies to improve their overall security posture. This proactive approach to cybersecurity can also enable them to stay ahead of emerging threats and prevent future incidents from occurring. By combining DFIR, they can better protect their sensitive data and systems from cyber threats.

Overall, the success of DFIR is evident in the increasing adoption of these techniques by organizations of all sizes and industries.

## KEY NOTES - FORENSICS

**Session:** Disclosure of child maltreatment  
**Session Type:** Strategic Session  
**Speaker:** Dr. Lindsay Malloy

- There is increased use of technology and AI in child protection and support services, enabling early detection and intervention for children at-risk.
- There is greater focus on trauma-informed care, ensuring that professionals working with children are aware of the potential impact of past trauma on their development and behavior.
- The integration of mental health support services into schools and communities allow more accessible and holistic care for children exposed to abuse and growing awareness and emphasis on cultural competence and diversity within child welfare agencies and support services, and ensure professionals are equipped to work with children from various backgrounds.
- The challenge is the limited resources and funding for child welfare agencies and support services, which may hinder their ability to effectively address and prevent child abuse. Another challenge is insufficient training and education for professionals involved in child abuse cases, including law enforcement, educators, and healthcare providers, leading to potential misinterpretation of children's disclosure patterns, or missed opportunities for intervention.
- The solution is strengthening collaboration between various stakeholders, such as schools, law enforcement, healthcare providers, and child welfare agencies, to create a comprehensive multidisciplinary approach to address child abuse. Entities must increase investment in research and development of evidence-based practices and interventions for interviewing and supporting children during the disclosure process, to minimize suggestibility and false allegations.

**Session:** Technological revolution: is it working with or against digital forensics?  
**Session Type:** Strategic Session  
**Speaker:** Meera Al Ansari, Keith Cottenden, Dr. Anderson Rocha

- The future will bring increasing reliance on artificial intelligence and machine learning for digital forensics, and incident response and expansion of Internet of Things (IoT) devices, leading to more data sources and evidence for investigators.
- There is greater emphasis on cross-border

collaboration and information sharing among law enforcement agencies. The importance of cloud forensics is rising as more data and services migrate to cloud-based platforms.

- The challenge is with handling and analyzing the massive volume of data generated by the ever-growing number of connected devices and overcoming encryption challenges to access relevant evidence on various devices and platforms. It is important to ensure forensic tools and techniques stay up to date with the latest technological advancements and criminal tactics.
- The way forward is to keep investing in continuous education, training, and professional development for digital forensic investigators and collaborating with the tech industry to develop advanced forensic tools and techniques to address new challenges. It also involves strengthening international cooperation and sharing of best practices among law enforcement agencies and implementing a human-in-the-loop approach where AI assists investigators, but the final decision-making and analysis capabilities remain with the human experts.

**Session:** New counter-drone technology and forensics in the cloud  
**Session Type:** Technical Session  
**Speaker:** Grant Jordan

- As drone technology advances, we can expect drones to become more autonomous, requiring less human intervention for tasks like navigation and decision-making.
- Drones will likely be integrated with Internet of Things (IoT) devices and artificial intelligence systems, enabling better data collection and analysis, as well as improved decision-making capabilities.
- The prime challenges are around privacy concerns, airspace management, security risks and technological limitations.
- It is important to implement comprehensive regulations and policies that can help address privacy, security, and safety concerns associated with drone usage. Fostering innovation in drone technology can help overcome current limitations, such as battery life and weather resilience, expanding their potential applications and benefits.

## KEY NOTES - FORENSICS

**Session:** Artificial Intelligence based detection and classification of material failure types for forensic engineering  
**Session Type:** Expert Hub  
**Speaker:** Sarah Ahmed Alkindi

- The future will see increased use of AI and machine learning in cybersecurity, proliferation of IoT devices and their impact on security, the rise of quantum computing and its effect on encryption and greater emphasis on privacy and data protection regulations.
- The challenges include keeping up with the constantly evolving threat landscape, addressing the growing cybersecurity skills gap, ensuring security of third-party vendors and supply chains, and balancing convenience and user experience with security.
- These can be curbed by implementing a robust multi-layered security approach, investing in cybersecurity training and awareness programs and regularly updating and patching software and hardware.

**Session:** Youth Empowerment in Forensic science  
**Session Type:** Strategic Session  
**Speaker:** Captain Abdulla Albastaki

Resources required to empower youth in forensic science include:

- Training and internships/mentorship programs
- Networking, events, and connection opportunities
- Investing in skills and knowledge and providing the tools and support needed to excel
- Creating opportunities to build experiences



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