**Fingerprint Analysis:**

A **fingerprint** in its narrow sense is an impression left by the [friction ridges](https://en.wikipedia.org/wiki/Friction_ridge) of a human [finger](https://en.wikipedia.org/wiki/Finger). The recovery of fingerprints from a crime scene is an important method of [forensic science](https://en.wikipedia.org/wiki/Forensic_science). Fingerprints are easily deposited on suitable surfaces (such as glass or metal or polished stone) by the natural secretions of sweat from the [eccrine glands](https://en.wikipedia.org/wiki/Eccrine_gland%22%20%5Co%20%22Eccrine%20gland) that are present in epidermal ridges. These are sometimes referred to as "Chanced Impressions".

In a wider use of the term, fingerprints are the traces of an impression from the friction ridges of any part of a human or other [primate](https://en.wikipedia.org/wiki/Primate) [hand](https://en.wikipedia.org/wiki/Hand). A print from the sole of the [foot](https://en.wikipedia.org/wiki/Foot) can also leave an impression of friction ridges.

Deliberate impressions of fingerprints may be formed by ink or other substances transferred from the peaks of friction ridges on the skin to a relatively smooth surface such as a fingerprint card.Fingerprint records normally contain impressions from the pad on the last joint of fingers and thumbs, although fingerprint cards also typically record portions of lower joint areas of the fingers.

Human fingerprints are detailed, nearly unique, difficult to alter, and durable over the life of an individual, making them suitable as long-term markers of human identity. They may be employed by police or other authorities to identify individuals who wish to conceal their identity, or to identify people who are incapacitated or deceased and thus unable to identify themselves, as in the aftermath of a natural disaster. Fingerprint analysis, in use since the early 20th century, has led to many crimes being solved. This means that many criminals consider [gloves](https://en.wikipedia.org/wiki/Gloves) essential  In 2015, the identification of [sex](https://en.wikipedia.org/wiki/Sex) by use of a fingerprint test has been reported.

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| https://upload.wikimedia.org/wikipedia/commons/thumb/0/06/Fingerprint_Loop.jpg/160px-Fingerprint_Loop.jpg |
| Loop (Right Loop)  |

|  |
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| https://upload.wikimedia.org/wikipedia/commons/thumb/4/49/Fingerprint_Whorl.jpg/160px-Fingerprint_Whorl.jpg |
| Whorl  |

|  |
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| https://upload.wikimedia.org/wikipedia/commons/thumb/5/5b/Tented_arch.jpg/160px-Tented_arch.jpg |
| Arch |

## Identification and classification of individual fingerprints

Fingerprint identification, known as dactyloscopy, or hand print identification, is the process of comparing two instances of friction ridge skin impressions from human fingers or toes, or even the palm of the hand or sole of the foot, to determine whether these impressions could have come from the same individual. The flexibility of friction ridge skin means that no two finger or palm prints are ever exactly alike in every detail; even two impressions recorded immediately after each other from the same hand may be slightly different. Fingerprint identification, also referred to as individualization, involves an expert, or an [expert computer system](https://en.wikipedia.org/wiki/Expert_system) operating under [threshold scoring](https://en.wikipedia.org/wiki/Adaptive_thresholding) rules, determining whether two friction ridge impressions are likely to have originated from the same finger or palm (or toe or sole).

An intentional recording of friction ridges is usually made with black printer's [ink](https://en.wikipedia.org/wiki/Ink) rolled across a contrasting white background, typically a white card. Friction ridges can also be recorded digitally, usually on a glass plate, using a technique called [Live Scan](https://en.wikipedia.org/wiki/Live_Scan). A "latent print" is the chance recording of friction ridges deposited on the surface of an object or a wall. Latent prints are invisible to the naked eye, whereas "patent prints" or "plastic prints" are viewable with the unaided eye. Latent prints are often fragmentary and require the use of chemical methods, [powder](https://en.wikipedia.org/wiki/Fingerprint_powder), or alternative light sources in order to be made clear. Sometimes an ordinary bright flashlight will make a latent print visible.

When friction ridges come into contact with a surface that will take a print, material that is on the friction ridges such as [perspiration](https://en.wikipedia.org/wiki/Perspiration), oil, grease, ink or blood, will be transferred to the surface. Factors which affect the quality of friction ridge impressions are numerous. Pliability of the skin, deposition pressure, slippage, the material from which the surface is made, the roughness of the surface and the substance deposited are just some of the various factors which can cause a latent print to appear differently from any known recording of the same friction ridges. Indeed, the conditions surrounding every instance of friction ridge deposition are unique and never duplicated. For these reasons, fingerprint examiners are required to undergo extensive training. The scientific study of fingerprints is called [dermatoglyphics](https://en.wikipedia.org/wiki/Dermatoglyphics%22%20%5Co%20%22Dermatoglyphics).

## Types of Finger Prints:

### Exemplar



Exemplar prints on paper using ink

Exemplar prints, or known prints, is the name given to fingerprints deliberately collected from a subject, whether for purposes of enrollment in a system or when under arrest for a suspected criminal offense. During criminal arrests, a set of exemplar prints will normally include one print taken from each finger that has been rolled from one edge of the nail to the other, plain (or slap) impressions of each of the four fingers of each hand, and plain impressions of each thumb. Exemplar prints can be collected using [Live Scan](https://en.wikipedia.org/wiki/Live_Scan) or by using ink on paper cards.

### Latent



Barely visible latent prints on a knife

Although the word latent means hidden or invisible, in modern usage for [forensic science](https://en.wikipedia.org/wiki/Forensic_science) the term latent prints means any chance or accidental impression left by friction ridge skin on a surface, regardless of whether it is visible or invisible at the time of deposition. Electronic, chemical and physical processing techniques permit visualization of invisible latent print residues whether they are from natural sweat on the skin or from a contaminant such as motor oil, blood, ink, paint or some other form of dirt.

Latent prints may exhibit only a small portion of the surface of a finger and this may be smudged, distorted, overlapped by other prints from the same or from different individuals, or any or all of these in combination. For this reason, latent prints usually present an "inevitable source of error in making comparisons", as they generally "contain less clarity, less content, and less undistorted information than a fingerprint taken under controlled conditions, and much, much less detail compared to the actual patterns of ridges and grooves of a finger."

### Patent

Patent prints are chance friction ridge impressions which are obvious to the human eye and which have been caused by the transfer of foreign material from a finger onto a surface. Some obvious examples would be impressions from flour and wet clay. Because they are already visible and have no need of enhancement they are generally photographed rather than being lifted in the way that latent prints are. An attempt to preserve the actual print is always made for later presentation in court, and there are many techniques used to do this. Patent prints can be left on a surface by materials such as ink, dirt, or blood.

### Plastic

A plastic print is a friction ridge impression left in a material that retains the shape of the ridge detail. Although very few criminals would be careless enough to leave their prints in a lump of wet clay, this would make a perfect plastic print. Commonly encountered examples are melted candle wax, putty removed from the perimeter of window panes and thick grease deposits on car parts. Such prints are already visible and need no enhancement, but investigators must not overlook the potential that invisible latent prints deposited by accomplices may also be on such surfaces. After photographically recording such prints, attempts should be made to develop other non-plastic impressions deposited from sweat or other contaminants.

### Electronic recording

There has been a newspaper report of a man selling stolen watches sending images of them on a [mobile phone](https://en.wikipedia.org/wiki/Mobile_phone), and those images included parts of his hands in enough detail for police to be able to identify fingerprint patterns.

Recent studies found that the improving cameras with increasing resolution of smart phones might have a high impact on users’ security: The back-facing camera of a device can be used to capture an image of the user’s index finger, which on smart phones using biometric means of authentication is often used to authenticate a user against the smart phone.

At the 31st [Chaos Communication Congress](https://en.wikipedia.org/wiki/Chaos_Communication_Congress), hardware hacker starbug presented how [DSLRs](https://en.wikipedia.org/wiki/Digital_single-lens_reflex_camera) with high resolution and equipped with a [long focus lens](https://en.wikipedia.org/wiki/Long_focus_lens) can be used to capture images of hands, or more specifically, fingers in order to use them for spoofing.

### Footprints

Friction ridge skin present on the soles of the feet and toes (plantar surfaces) is as unique in its ridge detail as are the fingers and palms (palmar surfaces). When recovered at crime scenes or on items of evidence, sole and toe impressions can be used in the same manner as finger and palm prints to effect identifications. Footprint (toe and sole friction ridge skin) evidence has been admitted in courts in the United States since 1934. The footprints of infants, along with the thumb or index finger prints of mothers, are still commonly recorded in hospitals to assist in verifying the identity of infants. It is not uncommon for military records of flight personnel to include bare foot inked impressions. Friction ridge skin protected inside flight boots tends to survive the trauma of a plane crash (and accompanying fire) better than fingers.

## Capture and detection

### Live scan devices



Fingerprint being scanned



Prisoner being fingerprinted.



3D fingerprint

Fingerprint image acquisition is considered to be the most critical step in an automated [fingerprint authentication](https://en.wikipedia.org/wiki/Fingerprint_authentication) system, as it determines the final fingerprint image quality, which has a drastic effect on the overall system performance. There are different types of fingerprint readers on the market, but the basic idea behind each is to measure the physical difference between ridges and valleys.

All the proposed methods can be grouped into two major families: solid-state fingerprint readers and optical fingerprint readers. The procedure for capturing a fingerprint using a sensor consists of rolling or touching with the finger onto a sensing area, which according to the physical principle in use (optical, ultrasonic, capacitive or thermal) captures the difference between valleys and ridges. When a finger touches or rolls onto a surface, the elastic skin deforms. The quantity and direction of the pressure applied by the user, the skin conditions and the projection of an irregular 3D object (the finger) onto a 2D flat plane introduce distortions, noise and inconsistencies in the captured fingerprint image. These problems result in inconsistent, irreproducible and non-uniform irregularities in the image. During each acquisition, therefore, the results of the imaging are different and uncontrollable. The representation of the same fingerprint changes every time the finger is placed on the sensor plate, increasing the complexity of any attempt to match fingerprints, impairing the system performance and consequently, limiting the widespread use of this [biometric](https://en.wikipedia.org/wiki/Biometric) technology.

In order to overcome these problems, as of 2010, non-contact or touch less 3D fingerprint scanners have been developed. Acquiring detailed 3D information, 3D fingerprint scanners take a digital approach to the analog process of pressing or rolling the finger. By modeling the distance between neighboring points, the fingerprint can be imaged at a resolution high enough to record all the necessary detail.

### Scanning dead or unconscious people

Placing the hand of a dead or unconscious person on a scanner to gain unauthorized access has become a common plot device. However, a *[MythBusters](https://en.wikipedia.org/wiki/MythBusters%22%20%5Co%20%22MythBusters)* episode revealed that this doesn't work (at least with the scanners available to the program). But [Adam Savage](https://en.wikipedia.org/wiki/Adam_Savage)and [Jamie Hyneman](https://en.wikipedia.org/wiki/Jamie_Hyneman) found a way to convert fingerprints lifted from the hand to a photographic form that the sensor would accept. For obvious reasons, they refuse to reveal the technique.

### Latent detection



Use of fine powder and brush to reveal latent fingerprints



Fingerprints dusting of a burglary scene

In the 1930s criminal investigators in the [United States](https://en.wikipedia.org/wiki/United_States) first discovered the existence of latent fingerprints on the surfaces of fabrics, most notably on the insides of gloves discarded by perpetrators.

Since the late nineteenth century, fingerprint identification methods have been used by police agencies around the world to identify suspected criminals as well as the victims of crime. The basis of the traditional fingerprinting technique is simple. The skin on the palmar surface of the hands and feet forms ridges, so-called papillary ridges, in patterns that are unique to each individual and which do not change over time. Even identical twins (who share their [DNA](https://en.wikipedia.org/wiki/DNA)) do not have identical fingerprints. The best way to render latent fingerprints visible, so that they can be photographed, can be complex and may depend, for example, on the type of surfaces on which they have been left. It is generally necessary to use a ‘developer’, usually a powder or chemical reagent, to produce a high degree of visual contrast between the ridge patterns and the surface on which a fingerprint has been deposited.

Developing agents depend on the presence of organic materials or inorganic salts for their effectiveness, although the water deposited may also take a key role. Fingerprints are typically formed from the aqueous-based secretions of the eccrine glands of the fingers and palms with additional material from sebaceous glands primarily from the forehead. This latter contamination results from the common human behaviors of touching the face and hair. The resulting latent fingerprints consist usually of a substantial proportion of water with small traces of amino acids and chlorides mixed with a fatty, sebaceous component which contains a number of fatty acids and triglycerides. Detection of a small proportion of reactive organic substances such as urea and amino acids is far from easy.

Fingerprints at a crime scene may be detected by simple powders, or by chemicals applied *in situ*. More complex techniques, usually involving chemicals, can be applied in specialist laboratories to appropriate articles removed from a crime scene. With advances in these more sophisticated techniques, some of the more advanced crime scene investigation services from around the world were, as of 2010, reporting that 50% or more of the fingerprints recovered from a crime scene had been identified as a result of laboratory-based techniques.



A city fingerprint identification room.

### Laboratory techniques

Although there are hundreds of reported techniques for fingerprint detection, many of these are only of academic interest and there are only around 20 really effective methods which are currently in use in the more advanced fingerprint laboratories around the world. Some of these techniques, such as [ninhydrin](https://en.wikipedia.org/wiki/Ninhydrin%22%20%5Co%20%22Ninhydrin), [diazafluorenone](https://en.wikipedia.org/wiki/1%2C8-Diazafluoren-9-one%22%20%5Co%20%221%2C8-Diazafluoren-9-one) and [vacuum metal deposition](https://en.wikipedia.org/wiki/Evaporation_%28deposition%29), show great sensitivity and are used operationally. Some fingerprint reagents are specific, for example ninhydrin or diazafluorenone reacting with amino acids. Others such as [ethyl cyanoacrylate](https://en.wikipedia.org/wiki/Ethyl_cyanoacrylate) polymerisation, work apparently by water-based catalysis and polymer growth. Vacuum metal deposition using gold and zinc has been shown to be non-specific, but can detect fat layers as thin as one molecule. More mundane methods, such as the application of fine powders, work by adhesion to sebaceous deposits and possibly aqueous deposits in the case of fresh fingerprints. The aqueous component of a fingerprint, whilst initially sometimes making up over 90% of the weight of the fingerprint, can evaporate quite quickly and may have mostly gone after 24 hours. Following work on the use of argon ion lasers for fingerprint detection, a wide range of fluorescence techniques have been introduced, primarily for the enhancement of chemically developed fingerprints; the inherent fluorescence of some latent fingerprints may also be detected. The most comprehensive manual of the operational methods of fingerprint enhancement is published by the UK Home Office Scientific Development Branch and is used widely around the world.

A novel technique proposed in 2007 aims to identify an individual's [ethnicity](https://en.wikipedia.org/wiki/Ethnicity), [gender](https://en.wikipedia.org/wiki/Gender), and dietary patterns.

## Research

The [International Fingerprint Research Group](https://en.wikipedia.org/wiki/International_Fingerprint_Research_Group) (IFRG) which meets biennially, consists of members of the leading fingerprint research groups from Europe, the US, Canada, Australia and Israel and leads the way in the development, assessment and implementation of new techniques for operational fingerprint detection.

One problem for the early twenty-first century is the fact that the organic component of any deposited material is readily destroyed by heat, such as occurs when a gun is fired or a bomb is detonated, when the temperature may reach as high as 500 °C. Encouragingly, however, the non-volatile inorganic component of eccrine secretion has been shown to remain intact even when exposed to temperatures as high as 600 °C.

A technique has been developed that enables fingerprints to be visualised on metallic and electrically conductive surfaces without the need to develop the prints first. This technique involves the use of an instrument called a **Scanning Kelvin Probe** (SKP), which measures the voltage, or electrical potential, at pre-set intervals over the surface of an object on which a fingerprint may have been deposited. These measurements can then be mapped to produce an image of the fingerprint. A higher resolution image can be obtained by increasing the number of points sampled, but at the expense of the time taken for the process. A sampling frequency of 20 points per mm is high enough to visualise a fingerprint in sufficient detail for identification purposes and produces a voltage map in 2–3 hours. As of 2010, this technique had been shown to work effectively on a wide range of forensically important metal surfaces including iron, steel and aluminium. While initial experiments were performed on flat surfaces, the technique has been further developed to cope with irregular or curved surfaces, such as the warped cylindrical surface of fired cartridge cases. Research during 2010 at [Swansea University](https://en.wikipedia.org/wiki/Swansea_University) has found that physically removing a fingerprint from a metal surface, for example by rubbing with a tissue, does not necessarily result in the loss of all fingerprint information from that surface. The reason for this is that the differences in potential that are the basis of the visualisation are caused by the interaction of inorganic salts in the fingerprint deposit and the metal surface and begin to occur as soon as the finger comes into contact with the metal, resulting in the formation of metal-ion complexes that cannot easily be removed.



Cartridge case with an applied fingerprint



Scanning Kelvin probe scan of the same cartridge case with the fingerprint detected. The Kelvin probe can easily cope with the 3D curvature of the cartridge case, increasing the versatility of the technique.

Another problem for the early twenty-first century is that during crime scene investigations, a decision has to be made at an early stage whether to attempt to retrieve fingerprints through the use of developers or whether to swab surfaces in an attempt to salvage material for [DNA profiling](https://en.wikipedia.org/wiki/DNA_profiling). The two processes are mutually incompatible, as fingerprint developers destroy material that could potentially be used for DNA analysis, and swabbing is likely to make fingerprint identification impossible.

The application of the new Scanning Kelvin Probe (SKP) fingerprinting technique, which makes no physical contact with the fingerprint and does not require the use of developers, has the potential to allow fingerprints to be recorded whilst still leaving intact material that could subsequently be subjected to DNA analysis. A forensically usable prototype was under development at Swansea University during 2010, in research that was generating significant interest from the British [Home Office](https://en.wikipedia.org/wiki/Home_Office) and a number of different police forces across the UK, as well as internationally. The hope is that this instrument could eventually be manufactured in sufficiently large numbers to be widely used by forensic teams worldwide.

## Detection of drug use

The secretions, skin oils and dead cells in a human fingerprint contain residues of various chemicals and their [metabolites](https://en.wikipedia.org/wiki/Metabolite) present in the body. These can be detected and used for forensic purposes. For example, the fingerprints of [tobacco smokers](https://en.wikipedia.org/wiki/Tobacco_smoking) contain traces of [cotinine](https://en.wikipedia.org/wiki/Cotinine%22%20%5Co%20%22Cotinine), a [nicotine](https://en.wikipedia.org/wiki/Nicotine) metabolite; they also contain traces of nicotine itself. Caution should be used, as its presence may be caused by mere contact of the finger with a tobacco product. By treating the fingerprint with gold [nano particles](https://en.wikipedia.org/wiki/Nanoparticle) with attached cotinine [antibodies](https://en.wikipedia.org/wiki/Antibody), and then subsequently with a fluorescent agent attached to cotinine antibodies, the fingerprint of a smoker becomes fluorescent; non-smokers' fingerprints stay dark. The same approach, as of 2010, is being tested for use in identifying heavy [coffee](https://en.wikipedia.org/wiki/Coffee) drinkers, [cannabis smokers](https://en.wikipedia.org/wiki/Cannabis_smoking), and users of various other drugs. In 2008, British researchers developed methods of identifying users of marijuana, cocaine and methadone from their fingerprint residues.

## United States databases and compression

In the United States, the [FBI](https://en.wikipedia.org/wiki/Federal_Bureau_of_Investigation) manages a fingerprint identification system and database called the [Integrated Automated Fingerprint Identification System](https://en.wikipedia.org/wiki/Integrated_Automated_Fingerprint_Identification_System), or IAFIS, which currently holds the fingerprints and criminal records of over 51 million criminal record subjects and over 1.5 million civil (non-criminal) fingerprint records. [US Visit](https://en.wikipedia.org/wiki/U.S._Visit) currently holds a repository of the fingerprints of over 50 million people, primarily in the form of two-finger records. In 2008, US Visit hoped to have changed over to a system recording FBI-standard ten-print records.



A city fingerprint identification office

## Validity

The validity of forensic fingerprint evidence has been challenged by academics, judges and the media. While fingerprint identification was an improvement on earlier [anthropometric](https://en.wikipedia.org/wiki/Anthropometry) systems, the subjective nature of matching, despite a very low error rate, has made this forensic practice controversial.

Certain specific criticisms are now being accepted by some leaders of the forensic fingerprint community, providing an incentive to improve training and procedures.

#### Defense

Fingerprints collected at a crime scene, or on items of evidence from a crime, have been used in [forensic science](https://en.wikipedia.org/wiki/Forensic_science) to identify suspects, victims and other persons who touched a surface. Fingerprint identification emerged as an important system within police agencies in the late 19th century, when it replaced anthropometric measurements as a more reliable method for identifying persons having a prior record, often under a false name, in a criminal record repository. The science of fingerprint identification has been able to assert its standing amongst forensic sciences for many reasons. In modern times, researchers can find traces of addictive drugs on just a fingerprint.

### Track record

Fingerprinting has served all governments worldwide during the past 100 years or so to provide accurate identification of criminals. No two fingerprints have ever been found identical in many billions of human and automated computer comparisons. Fingerprints are the fundamental tool for the identification of people with a criminal history in every police agency. They remain the most commonly gathered forensic evidence worldwide, and in most jurisdictions fingerprint examination is more common all other forensic examination casework combined. Moreover, it continues to expand as the premier method for identifying persons, with tens of thousands of people added to fingerprint repositories daily in America alone — far more than other forensic databases.

## Case Studies:

### René Ramón Sánchez

René Ramón Sánchez, a legal [Dominican Republic](https://en.wikipedia.org/wiki/Dominican_Republic) immigrant to the US, was arrested on July 15, 1995, on a charge of [driving while intoxicated](https://en.wikipedia.org/wiki/Driving_under_the_influence). His fingerprints were mistakenly placed on a card containing the name, [Social Security number](https://en.wikipedia.org/wiki/Social_Security_number) and other data for one Leo Rosario, who was being processed at the same time. Leo Rosario had been arrested for selling [cocaine](https://en.wikipedia.org/wiki/Cocaine) to an undercover police officer. On October 11, 2000, while returning from a visit to relatives in the [Dominican Republic](https://en.wikipedia.org/wiki/Dominican_Republic), René was misidentified as Leo Rosario at [John F. Kennedy International Airport](https://en.wikipedia.org/wiki/John_F._Kennedy_International_Airport) in New York and arrested. Even though he did not match the physical description of Rosario, the erroneously cataloged fingerprints were considered to be more reliable.[[44]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-44)

### Shirley McKie

[Shirley McKie](https://en.wikipedia.org/wiki/Shirley_McKie) was a police detective in 1997 when she was accused of leaving her thumb print inside a house in [Kilmarnock](https://en.wikipedia.org/wiki/Kilmarnock), Scotland, where Marion Ross had been murdered. Although McKie denied having been inside the house, she was arrested in a dawn raid the following year and charged with [perjury](https://en.wikipedia.org/wiki/Perjury). The only evidence the prosecution had was this thumb print allegedly found at the murder scene. Two American experts testified on her behalf at her trial in May 1999 and she was found [not guilty](https://en.wikipedia.org/wiki/Acquittal). The [Scottish Criminal Record Office](https://en.wikipedia.org/wiki/Scottish_Criminal_Record_Office) (SCRO) would not admit any error, although Scottish first minister [Jack McConnell](https://en.wikipedia.org/wiki/Jack_McConnell) later said it had been an "honest mistake".

On February 7, 2006, McKie was awarded [£](https://en.wikipedia.org/wiki/Pound_sterling)750,000 in compensation from the [Scottish Executive](https://en.wikipedia.org/wiki/Scottish_Executive) and the Scottish Criminal Record Office.[[45]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-45) Controversy continued to surround the McKie case and the [Fingerprint Inquiry](https://en.wikipedia.org/wiki/Fingerprint_Inquiry) into the affair finished taking evidence in November 2009.[[*needs update*](https://en.wikipedia.org/wiki/Wikipedia%3AManual_of_Style/Dates_and_numbers#Precise_language)][[46]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-46) The Inquiry Report was published on 11 December 2011.[[47]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-47)

### Stephan Cowans

Stephan Cowans was convicted of attempted murder in 1997 after he was accused of shooting a [police officer](https://en.wikipedia.org/wiki/Police_officer) whilst fleeing a robbery in [Roxbury, Massachusetts](https://en.wikipedia.org/wiki/Roxbury%2C_Massachusetts). He was implicated in the crime by the testimony of two witnesses, one of whom was the victim. There was also a fingerprint on a glass mug from which the assailant had drunk some water and experts testified that the fingerprint belonged to Cowans. He was found guilty and sent to prison for 35 years. Whilst in prison, Cowans earned money cleaning up biohazards[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia%3APlease_clarify)] until he could afford to have the evidence against him tested for [DNA](https://en.wikipedia.org/wiki/DNA). The DNA did not match his and he was released. He had already served six years in prison when he was released on January 23, 2004.[[48]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-boston-48) Cowans died on October 25, 2007.

## History

### Antiquity and the medieval period

Fingerprints have been found on ancient Babylonian clay tablets, seals, and pottery They have also been found on the walls of Egyptian tombs and on Minoan, Greek, and Chinese pottery, as well as on bricks and tiles from ancient Babylon and Rome. Some of these fingerprints were deposited unintentionally by the potters and masons as a natural consequence of their work, and others were made in the process of adding decoration. However, on some pottery, fingerprints have been impressed so deeply into the clay that they were possibly intended to serve as an identifying mark by the maker.

Fingerprints were used as signatures in ancient Babylon in the second millennium BCE. In order to protect against forgery, parties to a legal contract would impress their fingerprints into a clay tablet on which the contract had been written. By 246 BCE, Chinese officials were impressing their fingerprints into the clay seals used to seal documents. With the advent of silk and paper in China, parties to a legal contract impressed their handprints on the document. Sometime before 851 CE, an Arab merchant in China, Abu Zayd Hasan, witnessed Chinese merchants using fingerprints to authenticate loans. By 702, Japan allowed illiterate petitioners seeking a divorce to "sign" their petitions with a fingerprint.

Although ancient peoples probably did not realize that fingerprints could uniquely identify individuals, references from the age of the Babylonian king [Hammurabi](https://en.wikipedia.org/wiki/Hammurabi) (reigned 1792-1750 BCE) indicate that law officials would take the fingerprints of people who had been arrested. During China's [Qin Dynasty](https://en.wikipedia.org/wiki/Qin_Dynasty), records have shown that officials took hand prints, foot prints as well as finger prints as evidence from a crime scene. In China, around 300 CE, handprints were used as evidence in a trial for theft. By 650, the Chinese historian Kia Kung-Yen remarked that fingerprints could be used as a means of authentication. In his [*Jami al-Tawarikh*](https://en.wikipedia.org/wiki/Jami_al-Tawarikh) (Universal History), the Persian physician [Rashid-al-Din Hamadani](https://en.wikipedia.org/wiki/Rashid-al-Din_Hamadani) (also known as "Rashideddin", 1247–1318) refers to the Chinese practice of identifying people via their fingerprints, commenting: "Experience shows that no two individuals have fingers exactly alike." In Persia at this time, government documents may have been authenticated with thumbprints.

### Modern era



Fingerprints taken by [William Herschel](https://en.wikipedia.org/wiki/William_Herschel) 1859/60



Fingerprints used instead of signatures on an Indian legal document of 1952.

In 1863, Paul-Jean Coulier (1824–1890), professor for chemistry and hygiene at the medical and pharmaceutical school of the [Val-de-Grâce](https://en.wikipedia.org/wiki/Val-de-Gr%C3%A2ce) military hospital in Paris, discovered that [iodine](https://en.wikipedia.org/wiki/Iodine) fumes can reveal fingerprints on paper.[[75]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-75)

In 1880, Dr. [Henry Faulds](https://en.wikipedia.org/wiki/Henry_Faulds), a Scottish surgeon in a Tokyo hospital, published his first paper on the subject in the scientific journal [*Nature*](https://en.wikipedia.org/wiki/Nature_%28journal%29), discussing the usefulness of fingerprints for identification and proposing a method to record them with printing ink. He also established their first classification and was also the first to identify fingerprints left on a vial. Returning to the UK in 1886, he offered the concept to the [Metropolitan Police](https://en.wikipedia.org/wiki/Metropolitan_Police) in London but it was dismissed at that time. Faulds wrote to [Charles Darwin](https://en.wikipedia.org/wiki/Charles_Darwin) with a description of his method but, too old and ill to work on it, Darwin gave the information to his cousin, [Francis Galton](https://en.wikipedia.org/wiki/Francis_Galton), who was interested in anthropology. Having been thus inspired to study fingerprints for ten years, Galton published a detailed statistical model of fingerprint analysis and identification and encouraged its use in forensic science in his book *Finger Prints*. He had calculated that the chance of a "false positive" (two different individuals having the same fingerprints) was about 1 in 64 billion.

[Juan Vucetich](https://en.wikipedia.org/wiki/Juan_Vucetich), an Argentine chief police officer, created the first method of recording the fingerprints of individuals on file, associating these fingerprints to the anthropometric system of [Alphonse Bertillon](https://en.wikipedia.org/wiki/Alphonse_Bertillon), who had created, in 1879, a system to identify individuals by anthropometric photographs and associated quantitative descriptions. In 1892, after studying Galton's pattern types, Vucetich set up the world's first fingerprint bureau. In that same year, [Francisca Rojas](https://en.wikipedia.org/wiki/Francisca_Rojas) of [Necochea](https://en.wikipedia.org/wiki/Necochea%22%20%5Co%20%22Necochea), was found in a house with neck injuries, whilst her two sons were found dead with their throats cut. Rojas accused a neighbour, but despite brutal interrogation, this neighbour would not confess to the crimes. Inspector Alvarez, a colleague of Vucetich, went to the scene and found a bloody thumb mark on a door. When it was compared with Rojas' prints, it was found to be identical with her right thumb. She then confessed to the murder of her sons.



Women clerical employees of the[Los Angeles Police Department](https://en.wikipedia.org/wiki/Los_Angeles_Police_Department) being fingerprinted and photographed in 1928.

The Scheffer case of 1902 is the first case of the identification, arrest and conviction of a murderer based upon fingerprint evidence.[Alphonse Bertillon](https://en.wikipedia.org/wiki/Alphonse_Bertillon) identified the thief and murderer Scheffer, who had previously been arrested and his fingerprints filed some months before, from the fingerprints found on a fractured glass showcase, after a theft in a dentist's apartment where the dentist's employee was found dead. It was able to be proved in court that the fingerprints had been made after the showcase was broken.[[81]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-81) A year later, [Alphonse Bertillon](https://en.wikipedia.org/wiki/Alphonse_Bertillon) created a method of getting fingerprints off smooth surfaces and took a further step in the advance of dactyloscopy.

**Use of Gloves:**

Many criminals wear [gloves](https://en.wikipedia.org/wiki/Gloves) to avoid leaving fingerprints. However, the gloves themselves can leave prints that are as unique as human fingerprints. After collecting [glove prints](https://en.wikipedia.org/wiki/Glove_prints), law enforcement can match them to gloves that they have collected as evidence or to prints collected at other crime scenes. In many [jurisdictions](https://en.wikipedia.org/wiki/Jurisdictions) the act of wearing gloves itself while committing a crime can be prosecuted as an [inchoate offense](https://en.wikipedia.org/wiki/Inchoate_offense).

As many offenses are crimes of opportunity, assailants do not always possess gloves when they commit their illegal activities. Thus, assailants have been observed using pulled-down sleeves, pieces of clothing, and other fabrics to handle objects and touch surfaces while committing crimes.

### Log-in authentication and other locks

Since 2000, electronic fingerprint readers have been introduced for security applications such as log-in authentication for the identification of computer users. However, some less sophisticated devices have been discovered to be vulnerable to quite simple methods of deception, such as fake fingerprints cast in [gels](https://en.wikipedia.org/wiki/Gel). In 2006, fingerprint sensors gained popularity in the notebook PC market. Built-in sensors in laptops, such as [ThinkPads](https://en.wikipedia.org/wiki/ThinkPad%22%20%5Co%20%22ThinkPad), [VAIO](https://en.wikipedia.org/wiki/VAIO), [HP Pavilion](https://en.wikipedia.org/wiki/HP_Pavilion_%28computer%29) and [EliteBook](https://en.wikipedia.org/wiki/HP_EliteBook%22%20%5Co%20%22HP%20EliteBook) laptops, and others also double as [motion detectors](https://en.wikipedia.org/wiki/Motion_detector) for document scrolling, like the [scroll wheel](https://en.wikipedia.org/wiki/Scroll_wheel).

Following the release of the [iPhone 5S](https://en.wikipedia.org/wiki/IPhone_5S%22%20%5Co%20%22IPhone%205S) model, a group of German hackers announced on September 21, 2013, that they had bypassed Apple's new Touch ID fingerprint sensor by photographing a fingerprint from a glass surface and using that captured image as verification. The spokesman for the group stated: "We hope that this finally puts to rest the illusions people have about fingerprint biometrics. It is plain stupid to use something that you can't change and that you leave everywhere every day as a security token."[[104]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-104)

### Electronic registration and library access

Fingerprints and, to a lesser extent, iris scans can be used to validate electronic registration, cashless catering, and library access. By 2007, this practice was particularly widespread in UK schools, and it was also starting to be adopted in some states in the US.

## Absence or mutilation of fingerprints

A very rare medical condition, [Adermatoglyphia](https://en.wikipedia.org/wiki/Adermatoglyphia%22%20%5Co%20%22Adermatoglyphia), is characterized by the absence of fingerprints. Affected persons have completely smooth fingertips, palms, toes and soles, but no other medical signs or symptoms. A 2011 study indicated that adermatoglyphia is caused by the improper expression of the [protein](https://en.wikipedia.org/wiki/Protein) [SMARCAD1](https://en.wikipedia.org/wiki/SMARCAD1). The condition has been called *immigration delay disease* by the researchers describing it, because the congenital lack of fingerprints causes delays when affected persons attempt to prove their identity while traveling.

The anti-cancer medication  may cause the loss of fingerprints. Swelling of the fingers, such as that caused by [bee stings](https://en.wikipedia.org/wiki/Bee_sting), will in some cases cause the temporary disappearance of fingerprints, though they will return when the swelling recedes.

Since the elasticity of skin decreases with age, many [senior citizens](https://en.wikipedia.org/wiki/Senior_citizen) have fingerprints that are difficult to capture. The ridges get thicker; the height between the top of the ridge and the bottom of the furrow gets narrow, so there is less prominence.

Fingerprints can be erased permanently and this can potentially be used by criminals to reduce their chance of conviction. Erasure can be achieved in a variety of ways including simply burning the fingertips, using acids and advanced techniques such as [plastic surgery](https://en.wikipedia.org/wiki/Plastic_surgery) [John Dillinger](https://en.wikipedia.org/wiki/John_Dillinger) burned his fingers with acid, but prints taken during a previous arrest and upon death still exhibited almost complete relation to one another.[[116]](https://en.wikipedia.org/wiki/Fingerprint#cite_note-abel-116)