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The New Generation of Evidence in the Light of Historical Milestones in Criminalistics[2]

Abstract

The five milestones in the historical path of modern criminalistics, as detailed by the authors, are fundamentally tied to the old continent, Europe. However, the quintet of evidence – clue, blood, neutron activation, DNA and electronic data – already reveals that, in recent decades, there has been a shift in focus both territorially and substantively to law enforcement and courtrooms. It is not an exaggeration to say that we are witnessing a paradigm shift; traditional, "craftsmanship"-based evidence has been replaced by what are known as second-generation evidence. Thorough understanding, exploration and evaluation of these are essential for modern, effective 21st century criminal professionals working in criminal investigation, detection and ultimately in criminal proceedings.

Keywords: clue, material remain, neutron activation, DNA, electronic data, evidence, investigation

Abstract

A modern kori kriminalisztika történeti útjának – szerzők által részletesen elemzett – öt mérföldköve alapvetően az öreg kontinenshez, Európához kötődik. A nyom-vér-neutronaktiváció-DNS-elektronikus adatok kvintettjéből azonban már kiviláglik, hogy az utóbbi évtizedekben területi és tartalmi hangsúly-áthelyeződés van a bűnüldözésben és a bírósági tárgyalótermekben. Nem túlzó állítás, hogy paradigmaváltás tanúi vagyunk; a hagyományos-tradícionális-„kézműiparos" bizonyítékok helyébe ún. második generációs bizonyítékok léptek. Ezek alapos megismerése, felkutatása és értékelése a bűnügyi felderítésben, nyomozásban, végső soron a büntető eljárásbeli bizonyításban elengedhetetlenül szükséges a modernül gondolkodó, hatékonyan dolgozó, XXI. századi bűnügyi szakemberek számára.

Kulcsszavak: nyom, anyagmaradvány, neutronaktiváció, DNS, elektronikus adat, bizonyíték, nyomozás

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In our view, the history of modern forensics as a factual science of law enforcement, which began at the end of the 19th century and spanned the 20th century, coincides with the milestones we have marked below.[3] Namely, the:

A: fingerprint-based personal identification (starting between 1900-1910)
B: blood identification (1920s-'30s)
C: neutron activation analysis identification (from the 1930s-'40s)
D: DNA-based identification (since 1986)
E: electronical data in the service of reconnaissance (from the 1990s).

I. The first milestone, the fingerprint

From the beginning of the 19th century, personal identification as a goal came into the focus of criminalists. The development of related methods occupied the whole of Europe. In this spirit, Alfonse Bertillon, who served at the Paris police prefecture, also initially dealt with fingerprints from 1881. But in the end – as the first scientific (systematic) methodology[4] for forensic personal identification – he did not develop this, but a body measurement method (anthropometric, physiognomic, "portrait parlé") known as "bertillonage", containing 729 categories,[5] which was based on the uniqueness of individuals.[6] However, the measurement data[7] did not meet the requirement of permanence, so he could not create anything lasting, even despite its undoubtedly strong international impact.[8] His recognition of the uniqueness and permanence of fingerprints was appropriate, but he made a practical mistake there. In 1911, Leonardo da Vinci's famous painting, the Mona Lisa, was stolen from the Louvre. Bertillon was called in, who by then had considerable experience and a collection of fingerprints from those previously prosecuted. However, he was unable to find or identify the perpetrator, although – as it turned out – the fingerprints of a criminal with a criminal record named Vincento Peruggia, who was later arrested, were in his records.[9]

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[3] Of course, the milestone designation can be more detailed (from a different aspect), we could mention important moments from the history of forensics, but these – today we can say – appeared for decades, some centuries, we can call their existence "epochal".

[4] His work was also published in America: Bertillon, Alphonse: Signaletic instructions including the theory and practice of anthropometrical identification. The Werner Company, New York, NY, 1896.

[5] Bertillon, Alphonse: Une application pratique de l'antropométrie. Annales de démographie international. Masson, Paris, 1881; L'anthropométrie judiciare a Paris en 1889, Paris, 1890; De la reconstruction du signalement anthropometrque au moyen des vétements, Paris, 1892; Anthropometric identification. Melun, 1893.

[6] Bertillon is also credited with initiating a forensic "cornerstone", the photography of persons and crime scenes. He took three-sided portraits of already captured criminals with a special camera (chair) he made, while he developed the technique of metric photography for the scenes. (La photographie judiciare, Paris, 1890.; Reiss, also French (but also active in the "Lausanne de l'Institut de Criminologie" and later in Belgrade), also discussed criminal photography. Reiss, RA: La photographie judiciaire. Mendel, Paris, 1903. The next step in photographic personal identification was the Identikit system developed by Hugh C. McDonald in 1940, and then in 1959 Jacques Perry created the PhotoFIT identification method, which has already produced 15 billion different faces.

[7] He called the new method he developed "portrait parlé", or "talking portrait", indicating that he used various forms of facial features and put them together in such a way that he ended up with an image that was almost "cast into words". It could also be understood that the personal description spoke for itself, almost spoke because of its realism due to its accuracy, Bertillon believed.

[8] From 1890, all European criminal offices and many Americans used the Bertillon system, until the high cost and complexity of the registration technique, and mainly the system's unsuitability for identification, led to the permanent introduction of dactyloscopy in Europe in the first decades of the 20th century. Roth, Mitchel: Crime and Punishment: a History of the Criminal Justice System. Thomson Wadsworth, Belmont, CA, 2005. p. 384.

[9] Bertillon also made a mistake in the famous Alfred Dreyfus trial, when, as a commissioned handwriting expert,

This failure[10] only derailed Bertillon's career, not that of the fingerprint. It was introduced into personal identification procedures by[11] a Dalmatian-born (Croatian) police officer named Jan Vucetich (1858-1925), working under the name Juan Vucetich at the La Plata police station in Argentina. As early as 1891 – ten years before the British Henry – he managed to create the first usable fingerprint registration system, which he successfully used in solving practical cases.[12] In 1894 he published Dactiloscopia Comparada in which[13] he described his system, findings and experiences. In 1896, he established the world's first dactyloscopic identification workshop. However, his work remained virtually unknown outside of South America. Fingerprint identification[14] as a method of personal identification spread in Europe, Asia (India, Japan), then in the United States (from 1902-1903 at the New York Police Department), and Australia (almost the entire world) thanks to British researchers. Initially, (Sir) William Herschel,[15] a British official serving in India, the Frenchman Paul-Jean Coulier,[16] and the Scottish physician Henry Faulds[17] studied

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he misidentified the captain's handwriting.

[10] After its brief use in England between 1894 and 1900, Bertillon's anthropometric method lost its credibility in the United States, due to a prison case in 1903. A man named Willam West was admitted to Leavenworth Federal Prison in Kansas, and based on Bertillon's descriptions, it was determined that his body characteristics were exactly the same as those of a convict already serving his sentence. Thus, fingerprint identification came to the fore in the New World as a more reliable method of personal identification than Bertillonage. Houck, Max – Siegel, Jay: Fundamentals of Forensic Science. In Elsevier, Amsterdam-Boston-Heidelberg-London-New York-Oxford-Paris-San Diego-San Francisco-Singapore-Sydney-Tokyo, Vol. 8, 2006.

[11] It should be noted here that another continental expert, Berlin veterinarian Wilhelm Eber, had already made fingerprints and handprints for identification purposes in 1888, but he was unable to achieve a breakthrough with it, as the Prussian authorities showed no interest in his method.

[12] Vucetich, who emigrated to America from the Croatian territory (the village of Lesina) in 1884, proved the guilt of an (identified) woman in a murder case for the first time in 1892 based on a bloody fingerprint found at the scene. Thanks to this success, Argentina was the first country to switch from the Bertillonage to fingerprint identification, and the world's first fingerprint registry was also located here, with collection beginning in 1891 under Vucetich's leadership.

[13] Vucetich, Juan: Dactiloscopia Comparada. El Nuevo Sistema Argentino. Estadlédmiento Tipografico Jacobo Pacser, La Plata, 1894 (1904). As a result of his work, dactyloscopy was introduced in Brazil, Chile, Bolivia, Peru, Paraguay and Uruguay by 1908, but it did not become known beyond South America – due to its Spanish wording.

[14] The difference is that a different number of unique characteristics, minute points, are considered necessary to establish identity even today. For example, in Great Britain 16, in France 17, in Australia and New Zealand 12, in Turkey 8, in India it varies between 6-12 per state, and in the USA there is no such specific number. Erzinclioglu, Zakaria, Scenes, Alexandra, Pécs, 2006, p. 68. (Original title: The illustrated Guide to Forensics. London, 2004, p. 192.) (Furthermore, according to our research: in Austria 12, in Germany 8-12, in Spain 10-12, in Switzerland 12- 14 is the minimum requirement.)

[15] A summary of his work: Herschel, William James.: The Origin of Finger-printing. Oxford University Press, Oxford, 1916, p. 41. (He wrote this when, 28 years after his first fingerprint examination, he re-examined his own fingerprints and established their constancy.)

[16] Coulier had already proposed the use of latent fingerprints as a method of identifying criminals in 1863. Margot, Pierre – Quinche, Nicolas: Paul Jean Coulier (1824-1890) a prosecutor in the history of fingermark detection and their potential use for identifying their source (1863). In Journal Forensic Identification, No. 60, 2010, p. 129-134.

[17] In the 1850s, Herschel observed that illiterate Indians under his supervision used their fingerprints as signatures. He introduced the idea when distributing wages, salaries, and pensions; on the payrolls, the recipients confirmed receipt by taking fingerprints. (This avoided and prevented multiple withdrawals.) After using this method for 20 years, he noticed that these prints had not changed over time, meaning they could be used to identify individuals. At about the same time, the Scottish doctor Faulds, who was on a missionary mission in Japan, also noticed that the inhabitants left their fingerprints on pottery as signatures. After seeing how the perpetrator of a robbery was identified by his fingerprint, he wrote an article about it in the magazine Nature. (See: Faulds, Henry: On the skin-furrows of the hand. In Nature, Vol. 22, 1880, p. 605.) Reading this, Herschel also reported his experiences and demanded that his priority be established. Skin Furrows of the Hand. In Nature, Vol. 23, 1881, p. 76.

fingerprints and fingerprints with scientific thoroughness in Japan, followed by Francis Galton[18] (1822-1911) and (Sir) Edward Henry[19] (1850-1931). The former drew attention in London to the superiority of fingerprints over bertillonage, namely their permanence and uniqueness.

But he had not yet succeeded in finding a suitable system for registering fingerprints. This task (their classifiability) was solved by the latter (Edward Henry), the Chief Inspector of the British Police in Bengal. In 1901, as Chief of Police of London, he introduced the ten-finger dactyloscopic registration (of the Galton-Henry type) in England instead of the bertillonage.

On the European continent, after England, fingerprint registration was introduced in Hungary (in 1904), after the Budapest Deputy Chief of Police, Ferenc Pekáry, had studied the developed method in detail in London as a guest of Scotland Yard in 1902.[20] The system achieved its first success in the infamous Danish Four murders of 1907, when the perpetrators were identified based on the fingerprint registration data. As a result of this success, the Minister of the Interior, Count Gyula Andrássy Jr., ordered the establishment of the National Criminal Registry Office and a dactyloscopic collection with effect from 1 January 1909,[21] which was done and the perpetrators' fingerprint sheets were diligently collected for decades. During World War II, the collection, which already numbered hundreds of thousands at the time, was destroyed (disappeared) under unknown circumstances, so the registration and collection had to be restarted after the Holocaust. The aforementioned researchers and detectives recognized the forensic significance of fingerprints (and nowadays palm prints), pores in the grooves (poroscopy), and the multi-layered usability of them as early as the beginning of the 20th century.

The fingerprint is indeed the first milestone in time and – still preserved[22] – in its significance in forensics, but it cannot be ignored that other human and non-human (e.g. animal, tool-weapon-vehicle) surface and volumetric traces also existed alongside it, which were of significance to forensics even at the beginning of the modern period. Such are footwear and foot (sole) traces and teeth traces, which also played a major role in Gross's seminal work. Mouth, forehead and ear prints[23] did not yet have a significant role[24], their

[18] Summary work: Galton, Francis: Finger Prints. Macmillan and Co., London, 1892.

[19] Summary work: Henry, Edward Richard: Classification and Uses of Finger Prints. Routlegde, London, 1900.

[20] After his study trip to London, Ferenc Pekáry, who can also be considered the „Hungarian father of dactyloscopic registration", – after being supported in his ideas by the Chief of Police Béla Rudnay – sent two more police colleagues to get to know the English system and map it out precisely. After their return home, the actual organization began, as a result of which the fingerprint registration system set up already stored the fingerprint sheets of about six thousand criminals in 1904.

[21] The dactyloscopic department of the National Criminal Records Office was established based on Decree IM No. 24, 300 of 1908.

[22] Adding that its value has increased in recent decades, as the tiny sweat remains found in fingerprints (palm prints, handprints) at the scene can provide additional unique (DNA) identification as material remains.

[23] Bertillon had already dealt with the ear, but more with its dimensions than with its unique design. However, in 1948 Iannarelli was already purposefully photographing ears and traces and for decades he systematized, examined, and compared earmarks with earprints. He is credited with developing the 12-point "Iannarelli System". See: Iannarelli, Alfred Victor: Ear identification, forensic identification series. Pramoung Publishing Company, Fremont, CA, 1989.

[24] Regarding lip prints, we would like to mention that in 1902, anthropologist George Robert Fischer first observed their uniqueness, but it was only in the 1950s in Japan that substantive forensic (forensic cheiloscopy) research began, along with dental examinations. In 1961, basic research into lip print identification was also conducted in Hungary, after a lip print was found on a bottle at a murder scene, which was used to identify the perpetrator. See more details on this: Illár, Sándor: About lip prints. In Belügyi Szemle, Vol. 11, 1972. Lip print research was also conducted in Poland, led by Professor Jerzy Kasprzak. Among his works, we highlight: Kasprzak, Jerzy: Methodische Grundfragen der cheiloskopischen Begutachtung. In Kriminalistik und forensische Wissenschaften. Vol. 69, 1988, p. 70., and: Kasprzak, Jerzy: Cheiloscopy. In Siegel, Jay – Saukko,

uniqueness and identification were not yet included in the toolkit of forensics. When barefoot perpetrators were still present, recording footprints and examining them for comparative, individual identification was not a rare phenomenon. In the case of footwear traces, it was already clear that they were much more suitable for group (class) identification, unless unique characteristics appeared in the trace from the tracer.

The identification of tools and weapon traces was revived after the invention of the comparative microscope, reaching a higher level, enabling unique identification. This American invention, made in 1923, not by chance – along with the strengthening of natural science research, it was also famous for its free use of weapons and the gangster world of the time – is associated with Calvin H. Goddard (1891-1955), based on the preliminary work of the New York duo Charles Waite and Phillip Gravelle, and the Frenchman Victor Balthazard,[25] who thereby emerged as the "father" of forensic gunsmithing. He used the comparative microscope, which became the most important instrument in object examinations, to study the traces of test shots (captured in soft material) that he had made in the order of several thousand, whether they were found on the weapon or the ammunition (including the cartridge case and projectile).

The first results of forensic ballistics were applied in American courtrooms from 1928. In February 1929, in Chicago, then considered a "city of crime", four "gangsters" shot dead seven members of a rival gang that was threatening one of their businesses in a garage. Based on the bullets and cartridge cases, Goddard managed to find his way to the weapons used and the suspected perpetrators.[26] Based on his successful work, convincing opinions and suggestions, the FBI's ballistics department was established, including the world's largest (comparative) collection of firearms, which has been continuously expanding its collection ever since, partly with products released by manufacturers and partly with seized evidence. (For example, with homemade weapons.)

Goddard's comparative microscope also reached Europe via Egypt. The intermediary was Sydney Smith, head of the forensic department of the Ministry of Justice in Cairo, later a professor of forensic medicine at the University of Edinburgh. When he heard about Goddard's invention, he himself made a comparative microscope for his own use. With it, he exposed the assassin who shot the commander-in-chief of the Egyptian army, Sir Lee Stack Pasha, in the open street in 1925. Smith's English-language reports prompted Robert Churchill, the most famous London weapons expert, to introduce the comparative microscope in England (and to make it himself).[27] Around the same time, the first comparative microscopes were used in Germany and later in Hungary.

Pekka – Knupfer, Geoffrey (ed.): Encyclopedia of Forensic Sciences. Vol. 1-3, Academic Press, San Diego, 2000, Vol. 1, 358-362. he.

[25] In 1912, the Parisian forensic expert Victor Balthazar demonstrated in court that using enlarged photographs it was possible to show the identity between the bullet in a victim's body and the traces (notches) found on the bullet of the test shots fired from the weapon seized from the suspected perpetrator (Houssard). Roland, Paul: Scenes. In search of evidence. Pannon Literatúra Kft, Kisújszállás, 2009, 165.

[26] It should be noted here that there had been efforts to identify weapons and ammunition in Europe before. For example, in the late 1800s and early 20th century, Berlin forensic chemist Paul Jeserich examined bullets removed from victims, photographed them, and attempted to compare them with photographic traces of test bullets fired from weapons seized from potential perpetrators. However, his examination tools and methods – especially in the absence of a comparative microscope – were not yet reliable. The photographic technique also had a distorting effect.

[27] Hastings, Macdonald: The Other Mr. Churchill: A Lifetime of Shooting and Murder. Four Square, London, 1963.

II. The second milestone, the blood

The second major milestone in forensic identification was no longer a trace, but a material remain, specifically blood. It is not as if there had not been blood at the scene a thousand times before, but in the 1920s, mainly with the help of biologists, it was possible to recognize and identify blood with certainty. The second step was to distinguish between human and animal blood, and then to work out and prove who the blood came from. These three steps led to the identification ladder to the point where, in the first half of the 20th century, blood, as a material residue, was ranked among the “irrefutable” (physical) evidence alongside fingerprints.[28]

We believe it is symbolic that alongside the trace as an important identification mediator, another, increasingly important mediator, the material remains, quickly appeared. As if pushing the third mediator of previous centuries, the confession, into the background, including the confession of the perpetrator, which occasionally contradicts the interests of the investigation, and the testimony with countless uncertainty factors. At the same time, expert opinion enters as a new “religion”, as an expert religion, a statement of facts, which is valued among traces and, above all, material remains, especially in the 20th century.

How did we arrive at today’s blood identification results?

In response, we can say that in the early days of forensic bloodstain analysis, attempts were made to infer the course of the crime and the instrument used by the perpetrator from the shape of the bloodstains found at the scene. (One of the pioneers of this research work at the turn of the 19th and 20th centuries was, for example, the Berlin forensic chemist Paul Jeserich.)

More important than examining the shape of the bloodstains was the determination that the stains actually contained blood,[29] as rust, paint and other contaminants (such as jam or today ketchup) can easily be mistaken for blood. In 1853, a Polish anatomist, Ludwig Teichmann, developed the first method that reliably detected blood. By treating with acetic acid, characteristic crystals are formed in the presence of blood. The red blood cells in human and animal blood differ in size, which can be seen using a microscope. In practice, however, in dried bloodstains, the red blood cells lose their characteristic shape and cannot be reliably distinguished from each other. It was not until 1901 that the German Paul Uhlenhuth discovered the method (precipitation test) that made it possible to distinguish human blood from animal blood types using rabbit serum.

The next step in development was the Austrian immunologist and pathologist Karl Landsteiner (1868-1943) who discovered that human blood can be divided into different groups (AB0)[30], and then Franz Josef Holzer, a forensic pathologist at the University of Innsbruck, developed the absorption method in 1930 for the reliable group determination of traces of blood. The Finnish KO Renkonen proved that certain plants, such as the extract of the Alpine goldenrod, react to the “0” group, thus making that blood type quickly and easily detectable. In addition, the Berlin forensic pathologist Otto Prokop and the London-based Race and Cambridge-based RRA Coombs serologists were engaged in similar research. The “mixed agglutination” (microtrace) blood group determination method he developed in 1956

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[28] In forensic terms, the term bloodstain used in common parlance is incorrect; it is actually a material remain. Although we would like to add that blood can be interpreted as a trace when its stained, dripped form allows us to deduce, for example, what position the victim was in at the time of the attack; was he sitting, standing, moving, or lying down. It can also often be determined that he was dragged or crawled to where he was found.

[29] In 1937, the German Walter Specht first used luminol – still used today – to quickly detect blood. (In the dark, luminol causes blood to glow and glow.)

[30] Landsteiner also discovered the AB blood group in 1902, for which he received the Nobel Prize in Physiology (Medicine) in 1930.
He is also credited with first describing Rh blood groups in 1940, together with Philip Levine and Alexander Wiener.

was included in textbooks under the name Coombs test.[31] These were followed by the discoveries of the Rh, MnSs, Lewis, and white blood cell antigen systems, even before DNA identification. As well as the scientific discovery that blood type can be determined from saliva and other body fluids. This was already applied in the history of forensics in 1939.

The discoverers listed so far were natural scientists, the question is whether there was anyone who "translated the knowledge into the language of forensics", that is, whether there was an outstanding user of scientific results. Just as Gross from the monarchy is a symbolic (world) figure of the forensic history of the late 19th century, the British Galton-Fault of fingerprint identification in the early 20th century, and the American Goddard of weapon identification in the 1920s, so too the material remains have their international icon, their "father", in the person of the Frenchman Edmond Locard (1877-1966).

In addition to examining[32] fingerprints and pores[33], he also participated in the examination of many other material remaining besides blood. Locard[34] – as a student of Alexandre Lacassagne – produced outstanding results in the field of micro-material remains.[35]

We can also mention the equally active Gaston Edmond Bayle, who headed the laboratory of the Paris police prefecture from 1921 to 1929, Max Frei-Sulzer,[36] head of the scientific service of the Zurich police, EP Martin, who developed the forensic department of the Basel prosecutor's office from the very beginning after World War II, Rudolph Archibald Reiss[37] (also French) and (his student) Marc Bischoff, based in Lausanne, Robert Heindl, who also worked in Munich, Dresden and Berlin, August Brünnig from Berlin and Harry Södermann from Stockholm[38], the professor from Naples and then Brussels, Alfredo Niceforo,[39] the anthropologist from Rome – a student of Lombroso – Salvatore Ottolenghi,[40] New York's first chief medical examiner, Charles Norris, and his colleague, toxicologist Alexander O. Gettler.

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[31] All this is written in detail in Nuland, Sherwin B.: Doctors and the biography of medicine. Alfred A. Knopf. Inc., New York City, 1988.

[32] Between 1911 and 1914, Locard, who studied both medicine and law, worked extensively on fingerprints. He proposed a system of identification with 12 minute dots and no differences, without any doubt. Locard, Edmond: La prevue judiciaire par les empreintes digitales. In Arch. Anthrop. Crim. Med. Leg. Psychol. Norm. Pathol. Vol. 28, 1914, p. 312-348.

[33] Locard, who also edited the journal Revue internationale de criminalistique (1938), is also credited with initiating pore examination (poroscopy), as he isolated and counted the pores and sweat glands – which also show uniqueness – within fingerprints.

[34] In 1889, Professor Alexandre Lacassagne of Lyon (editor of the journal "Archives d'anthropologie criminelle") proved, through his studies of clues and material remains, that a fired projectile can be matched to the weapon that fired it, since the grooves of the gun barrel leave unique traces on the projectile. (In 1898, the German chemist Paul Jeserich already applied the comparative examination in practice, and in 1920, the physicist John Fischer confirmed the essence of the discovery, after he was able to accurately map the inside of the gun barrel, the course and shape of the grooves, with the helixometer he invented.)

[35] Locard, Edmond: Manuel de technique policière. Payot, Paris, 1923., and the 3268-page, six-volume Traité de criminalistique. Desvigne, Lyon, 1931-1940.

[36] Among the "microtrace" inventions of the Swiss Frei-Sulzer was the method developed after 1950, which was called the "adhesive tape method." Today we would call it the "cellox" method. He glued the points of the scene that could have come into contact with the perpetrator's clothes, or the places on the suspect's clothes that were in contact with the scene of a crime, with cellox tape or some other similarly strong adhesive tape. Then he simply peeled off the adhesive strip, to which clues that were otherwise invisible to the naked eye adhered, and which he could then examine with an electron microscope.

[37] Heindl, Robert: System und Praxis der Dactyloscopy. (1. edition) Berlin-Leipzig, 1921.

[38] Södermann, Harry – O'Connell, John: Modern Criminal Investigation. Funk & Wagnalls, New York, 1952. (The Swedish Södermann was, by the way, a student of Locard in Lyon.)

[39] Niceforo, Alfredo: La police et l'enquete judiciare. Librairie Universelle, Paris, 1907.

[40] Ottolenghi, Salvatore: Polizia scientifica. Rome, 1910; L'antropologia criminale. E il diritto penale in formazione, Universita di Roma, Roma, 1916; Trattato di polizia scientifica, Rome, 1931.

The electron microscope, invented at the turn of the century (between 1924-30, by Louis de Brogle), and its thousands of increasingly accurate, powerful, versatile and variable versions, contributed greatly to their success in all of them.

Thanks to the electron microscope, basic research on other material remains intensified in parallel with blood research. This was true for both human and non-human remains. For example, in the former group, hair[41], fur, skin, nails, teeth, bones, marrow, saliva, sputum, vaginal discharge, semen, breast milk, colostrum, urine, feces, and in the latter group, animal and plant remains,[42] as well as glass, textiles, metal, paper, fiber, blades of grass, pollen, soil, dust, (gunpowder),[43] plastic, rubber, minerals, ink, mud, rust, chemicals, oil, grease, ash, candles, poisons, natural and artificial drugs, explosives, and chemical substances.

Among the material remains, arsenic, as a toxic substance, has a prominent place in the history of forensic science. As we have already mentioned, the birthplace of forensic medicine is Europe, in this regard, in the United States, which is now the standard-bearer, it only reached its humble beginnings after World War I, thanks mainly to English and German immigrants and European achievements. In the 19th century, "forensic toxicology" was still part of medicine, better known by its name – which later gained its independence – toxicology, the first epoch-making discovery of which dates back to 1836 and is associated with the name of the English chemist James Marsh from Woolwich. He created the apparatus named after him in the literature (the first Marsh apparatus), which made it possible to convert arsenic in extracts obtained from the body fluids and tissues of the deceased into arsenic hydrogen, from which arsenic precipitated on a porcelain cup at the end of the apparatus. With the apparatus improved in the later stages of development, researchers were able to determine the approximate amount of arsenic from the size of the "arsenic mirror". After World War II, one of the most significant innovations in toxicology was the use of paper chromatography for the isolation and detection of poisons.

III. The third milestone is the application of the neutron activation method

The third milestone can be marked by the appearance of the "atomic detective" starting in the 1940s and 1950s. Again, basic scientific research brought the initial results, followed by their forensic application. With the neutron activation method, experts were able to conduct previously unimaginable in-depth analyses of material remains. We can also say that the previously unseen world or the truly latent world became increasingly visible. The identification of individual material remains reached a new level with this technology.

Fleeing World War II from the European continent, countless scientists arrived in the peaceful American continent, conducting basic scientific research. Due to the calm and high-quality working conditions, the results began to appear on the distant continent, and it is not by chance that their forensic applications were first found here.

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[41] In 1910, Parisian medical experts Victor Balthazar and Marcel Lambert examined animal and human hair and published the first treatise on the subject, entitled "Le poil de l'homme et des animaux."

[42] In 1904, the German Georg Popp was the first to perform forensic identification on botanical materials, soil, and plant remains.

[43] In 1930, Mexican Tomas Gonzales pioneered the so-called dermal nitrate test, which he used to detect gunpowder traces on the skin. His method was used in practice until the 1960s. Regarding gunpowder, we should also highlight that in 1959, HC Harrison and R. Gilroy developed a special color test for detecting gunpowder remains. A rubbing sample was taken from the skin of the victim and/or perpetrator's hand and tested with chemical reagents, which caused the reagents to change levels in response to trace amounts of components, such as lead, barium, and antimony. (They showed if they were actually present on the skin.)

The Canadian Robert E. Jervis, as a professor of chemistry at the University of Toronto, took a pioneering role in the use of neutron activation analysis in forensics in 1955. He analyzed material residues with this method, focusing especially on hair samples and their comparative examination. After 1958, Auseklis and his student K. Perkons conducted a large-scale experiment on more than 1,000 hair samples to examine the possibilities of "nuclear" hair comparison. At the same time, he was already a scientific representative of the methodology in the United States. Vincent P. Guinn, director of the activation analysis program at "General Atomics" in San Diego, applied it mainly to the examination of material residues related to cars (grease, tire rubber, glass, plastic, varnish, etc.).

The essence of neutron activation analysis is that all human (and animal and non-human remains) may contain trace elements in micro-quantities (up to one millionth of a milligram) that can be detected by the sensitive instrument. The sample to be tested is placed in a plastic capsule in a very large experimental reactor (taking up a lot of space, no longer laboratory-sized, as it was before), where it is exposed to a neutron flux. Under the influence of neutrons, the trace elements become radioactive and emit radiation, the intensity of which varies from element to element. The type and quantity of the trace elements present can be determined by the incredibly fast measurement of this radiation. (Today, the types and quantities of trace elements can be displayed on a computer screen /printed/, thus making the analysis results and comparability simple, but at the same time much faster and of higher quality than previous residue tests. The previous laboratories have been replaced by "power plant" research workshops and halls, test tubes have been replaced by control panels, and residue testing has changed in speed from trains to airplanes.

The radiation emitted by trace elements that have become radioactive during forensic neutron activation analysis is measured using various devices, such as Geiger counters and scintillation tubes. Of the various types of radiation, gamma rays are the most commonly measured. The measurement results are transferred to "spectrograms," graphs resembling heat curves, on which "peaks" indicate the presence of certain (specifically marked) trace elements (such as gold, silver, copper, sodium, lead, germanium).

For example, the method was (and still is) excellent for examining hair strands. The curves created based on the vibrations obtained accurately show the trace elements contained in them, and a single hair strand (or perhaps a fragment of a drug, which is common these days) found at the scene or on the victim, the potential perpetrator, their body, clothing, or apartment can be suitable for precise comparison with sample hair, or[44] for the detection of the content and components (of the drug, poison) (in portions).

In the second half of the 20th century, an Atlantic shift is visible in the results of forensic science. The 19th century belonged to Europe with the Habsburg-Prussian-French axis, the first decades of the 20th century were already hand in hand with England, then in the 1920s America also started with ballistics, and in the 1950s (with neutron activation) there was a shift in emphasis in favor of the Anglo-Saxons. It is no coincidence that the next milestone, DNA, also has an American-English connection, and the fifth milestone, digital data, definitely starts from the American continent, turning to the 21st century.

[44] Before Napoleon's body was transported from the island of Saint Helena to the Church of the Invalides, the remains were also examined using the neutron activation method, since the decay properties of radioactive materials can be used to detect small amounts of arsenic in the human body that cannot be detected otherwise. Trace elements made radioactive by neutron radiation showed that Napoleon's hair contained thirteen times the usual amount of arsenic. As an explanation, one hypothesis suggests that the emperor was poisoned, but secondly, it cannot be ruled out that, given the long time that elapsed between the burial and the examination (20 years), the amount of arsenic in question came from the soil and finally, thirdly, it cannot be ruled out that Napoleon used the poison as a stimulant (or a digestive remedy), which gradually accumulated in his body. For more information, see Wilson, Keith D.: Cause of Death, Murder and Forensic Medicine. Writer's Digest Books, Cincinnati, 1992.

IV. The fourth milestone, the DNA

In the history of (modern) forensic identification, we can mark the fourth milestone, the "star" that began in the last quarter of the 20^{th} century, DNA, its discovery and comparative analysis.

The essence of the studies and findings related to this is that DNA (deoxyribonucleic acid, a compound belonging to the group of nucleic acids) is found in all living cells due to inheritance, its ratio within a cell is constant and is characteristic of the given species, including humans. Within the human species, it has a special structure characteristic of individuals, carrying a kind of "genetic information", a signal system.

DNA was discovered by Swedish biologist Miescher in 1868, but its role in heredity was not yet understood. The model of the chemical structure of DNA was described in 1953 in the scientific journal Nature by two Cambridge researchers, Francis Crick and James Dewey Watson, for which they received the Nobel Prize in 1962.

IV.1. The advantages and disadvantages of the DNA tests

The question rightly arises: what advantages and disadvantages have DNA tests had and do they have?[45]

The advantages that were noted then, and can be noted today, are:

a) It is a flexible method because DNA tests allow for unique identification even in cases where this would not be possible with other methods.[46]

b) It provides an opportunity for uniqueness and individualization, because the chance of two people having identical DNA samples is 1 in 100 million or 1 in 30 billion, depending on the identification methods, except for identical twins. (Note that in this case, fingerprinting is "stronger" than DNA testing based on material remains, since identical twins have different fingerprints and smells);

c) It is characterized by permanence, as the possibility of DNA identification persists for thousands of years, and the examination can be performed even on very old bone remains.

d) Its versatility is demonstrated by the fact that countless biological remains contain (can) DNA, making it suitable for establishing identity or exclusion.

e) Due to its multifunctional applicability, it can be used not only in cases of crime, but also in cases of missing persons, connecting body parts, in cases of extraordinary deaths, and in identifying possible unknown bodies. Moreover, it is possible to draw conclusions about the given person and their characteristics (race, gender, eye color, hair color, etc.) based on the DNA sample.

f) It also has the function of assisting and accelerating field work by facilitating the selection of relevant evidence. During the on-site inspection, the expert can determine, for example, in a few moments, which of the bloodstains found are identical and which come from the victim. On-site DNA testing can also be of great help in the fight against bioterrorism. (In a specific case, letters filled with white powder were sent to government offices in the USA, claiming that the envelope contained anthrax bacteria. Entire city blocks had to be sealed off until the material was sent to the laboratories and the results came back that the powder was harmless. On-site DNA testing could have prevented this and saved a lot of money.)

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[45] Campbell also dealt with the question and the answer (with a narrower list). See: Campbell, Andrea: Forensic Science: Evidence, Clues, and Investigation. Chelsea House Publishers, Philadelphia, 2000, p. 100.

[46] Baskin, Deborah – Sommers, Ira: The influence of forensic evidence on the case outcomes of homicide incidents. In Journal of Criminal Justice. Vol. 38, 2010, p. 1141-1149.

g) Very convincing, stable evidence in courtrooms around the world, not just in labs. (In the ”two-front battle”, the thoroughly, scientifically developed identification method holds its ground on both fronts.)

Among its disadvantages we can mention:

a) It is an expensive procedure that requires advanced technical equipment. Unfortunately, DNA testing is still much more expensive than, for example, serological testing.

b) The examination time, the special, detailed examination, and the final word are lengthy and take more time than with traditional (first generation) procedures.

c) The method is complicated, a complex procedure requiring great (special) expertise.

d) DNA testing standards are not yet global standards, neither within nor outside individual states.

e) Risk of contamination among samples (field or test).[47]

f) There are also legal problems with DNA tests, as sampling may conflict with certain human rights. Based on fundamental, constitutional rights, DNA samples may only be taken, stored, and used in cases and in the manner prescribed by law. (Including the definition of the circle of those entitled to access the data). The so-called mass testing could not take place in many countries (for example, in the USA) precisely because of the protests of human rights organizations.

IV.2. The landmark DNA identification as a pioneer of second generation evidence

Upon seeing the subtitle, the questions immediately arise: what were the first-generation evidence? Why does DNA show the shift? What and why do they belong [48] to the so-called “second-generation” evidence, a conceptual name we ourselves agree with, parallel to the use of the term “milestone”. (We summarized the grouping of generational evidence in one table and – supplemented with traditional ones – in a second table after the responses.)

In order to answer the questions that may also strengthen the “milestone” nature of DNA identification, we emphasize that the 1980s were epoch-changing (paradigm-changing) for several reasons through the lens of forensics. Scientific research related to the further development of computers, mobile phones, and the Internet is revived, and the seeds of digital data included in the next subsection appear. In addition to the traditional, ,,first-generation” forms of forensic identification procedures and tools that could previously be called classic and traditional, such as clues (including fingerprints, foot prints, footwear, tools, weapons, and vehicle prints), material residue tests (blood-related serology, hair, textile fibers, toxins, paper, glass, etc.), and handwriting and typing tests, a different approach, form, tool, and method requiring people is emerging. Science, including the natural sciences and the real sciences, into which the field of computer science has also grown, is constantly providing new answers to new (crime) challenges.

In the advantages and disadvantages of DNA identification (as well as in the description of the essence of DNA identification), we have already hinted that this new

[47] Like other evidence, DNA is only as reliable as the conditions under which it is discovered, collected, stored, and presented. The greatest threat to genetic identification is contamination of samples. Because polymerase chain reaction (PCR) can be performed on even the tiniest of samples, modern forensic experts use this method to amplify individual sections of DNA. PCR can successfully amplify even a single molecule of DNA. This means that even the smallest amount of DNA from other sources can contaminate evidence, making it garbled or even unusable.

[48] The term can also be found in the title of the following study: Murphy, Erin: The New Forensic: Criminal Justice, False Certainty, and the Second Generation of Scientific Evidence. In California Law Review, Vol. 95, 2007, p. 721.

technology (as well as other second-generation data collection and identification) is different from the previous ones, for the reasons systematized and listed below.

a) Compared to the simple forms and clear formulas and methods of application of traditional, first-generation evidence, everyday knowledge is not enough to understand their essence; they are too polished and too scientific for laypeople.

b) The identification and even sample collection procedures are much more complicated than with traditional methods.

c) New technologies require very high-level and valuable (expensive) equipment.

d) The costs of equipment and procedures are also many times higher than before, but at the same time their "production", i.e. their production of results is becoming faster and more efficient. In developed countries (for example, England, the USA), DNA tests are increasingly coming to the fore and the number of non-DNA tests is decreasing. This trend – in our opinion – will only continue and as a result of the concentration of forces, we will experience this phenomenon in more and more countries, especially where serious attention is paid to filling the databases. (See, for example, the CODIS system in the USA, where the number of already reported "cold hit" cases is also constantly increasing.)

e) Very few truly specialized professionals are familiar with complicated procedural forms and "pursue" the professional application of technologies, the training technology and cost of which are much higher than in the case of first-generation procedures and professionals.

f) Counter-evidence also becomes more difficult for the subjects of the defense, such as the potential defendant, the defendant and his/her defense attorney, since they do not have such special expertise; understanding the expert opinions prepared is not an easy task at all, and very few people can emerge as counter-experts without deep knowledge, one might say knowledge requiring scientific sophistication and expensive tools, auxiliary materials, and experience.

g) The defense (including the potential defendant) is database-dependent, meaning it does not have digital data with which it could truly attack and weaken the robust, relevant data set (for example, it does not have its own digital voiceprint identification and image analysis technology).

h) As follows from points c and e, opinions and test results are usually produced in state (sometimes also state-owned university) laboratories with a heavy budget and based on teamwork, in contrast to traditional expert opinions, which operated and operate with much smaller equipment and human resources.

i) As for second-generation digital methods, including (numeric-based) biometric[49] personal identification, digital GPS-Global Positioning System, or radio frequency identification, (Radio Frequency Identification) location determination, digital open or secret audio[50] and video recordings, (SMS, MSM, Facebook, Twitter, MySpace, StudiVZ, Xing, etc.) message checks, data seizures, results of virtual house searches, website checks, digital voice identification, public digital camera systems, computer data acquisition, digital data mining and rasterization, digital retina and iris identification, the results come very quickly, almost at lightning speed, compared to the restrained, one might say slowness, of traditional, first-generation devices.

j) The new generation of evidence indicated in point i) is also characterized by the fact that it is very difficult for perpetrators to get rid of them or not to create digital clues. They

[49] The word biometric comes from the Greek words bios = life and metron = size.

[50] The history of voice identification includes the publication of Alexander Melville Bell's book Visible Speech in 1882. In 1941, the voice spectrograph was created at Bell Laboratories in New Jersey, which drew the voice on paper, and in the 1960s, the New York police used the "voiceprint" for personal identification in a plane bomb threat case.

can be constantly present in the images of public cameras, and they immediately leave a digital clue and data behind by going online, as well as by making any phone call, going to a cell tower, or even turning on their cell phone. (The space of the private sphere is also immediately reduced.)[51]

k) Second-generation techniques are usually also protected as intellectual property (for example, Jeffreys PRCP technology or the GPS system, and we could list many more) in contrast to first-generation procedures.

l) The neutron activation method or voice identification can be seen as a "bridge" between the two generations of evidence groups in time and space. In both cases, the equipment and expert requirements are already high, while the method is still transparent and understandable for laypeople. (It is another matter that the former has little chance of being used in the private sector due to lack of funds.) The fingerprint is already Janus-faced, double-sided, because it is included in the first generation group with traditional fingerprint identification, but AFIS has already entered the second generation group with its digital method. (The time of its launch is no coincidence: the 1980s-90s worldwide.)

m) A special merit and distinguishing feature of second-generation devices is that they can be much more proactive and crime-preventive than their old counterparts, which are constantly reactive, pursuing crime, "on the trail" of criminals, and only active afterwards. (For example, the digital content of phone calls or computers may already indicate the commission of planned crimes, relevant criminal data fragments can be "picked up" from the airwaves and digital memories, and intervention can take place in due time. Digital scanners can also prevent airport bombings by detecting explosives in advance.)

n) However, their disadvantage is that they are much more intrusive in private life, just think of digital audio and video recordings, message reading, open and secret cameras. Often, almost regardless of the fact that the target person is connected to a crime or not, they become visible at every step. (with the help of satellites, signal relay towers, video cameras, etc.)

Here is a (triple) table summarizing the distribution of generational evidence:

First generation evidence	**Intermediate-double Evidence (First and second at the same time)**	**Second generation evidence**
1. clue (including, for example, fingerprints, footprints, footwear, tools, weapons, and vehicle prints), 2. material remain tests (blood-related serology, hair, textile fibers, toxins, paper, glass, etc.)	1. neutron activation method (for examining material remains) 2. speech and voice recognition 3. Fingerprinting, traditional and with AFIS technology	1. DNA identification, 2. biometric identifications (biometric scans): 3. biometric scanning is often used at airports, offices, and protected institutions, 4. digital voice recognition, 5. data from public digital camera systems and image analysis programs, 6. digital retina and iris scanning, identification, 7. application of reconstruction software (for example: computer-

[51] Diffie, Whitfield – Landau, Susan: Privacy on the Line. The Politics of Wiretapping and Encryption. MIT Press, MA, Cambridge, 1998.

3. handwriting and typing tests		aided facial scene reconstruction), 8. hand geometry test 9. digital data mining, rasterization, 10. a digital GPS system that monitors the movements of criminals or those planning to commit crimes, 11. radio frequency identification (RFID), 12. secret audio-speech-image-video recordings used mainly in connection with corruption, organized crime, and terrorist acts, 13. data that can be stored or transmitted on a mobile phone, fax machine (video recorder), computer (anything that contains a microprocessor) or its accessories (desktop PC, laptop, netbook, tablet, disks, pendrive, etc.), (Computer Forensic Evidence), 14. digital data from virtual house searches, 15. data floating on social networks (Facebook, Twitter, etc.), YouTube, website monitoring data, 16. data from computer data acquisitions and cyber investigations.

At the same time, if we review the range of pre-modern, traditional (historical), mainly personal evidence, then our table can be expanded with a „preliminary evidence” category, a fourth column. In our opinion, these cannot be classified as evidence that forensic science existing within the framework of the rule of law can „afford” or include in its toolbox. Some of these have not been forgotten (for example, the fair interrogation of witnesses or the accused), but their role has weakened, they have been somewhat relegated to the background and, according to our tendentious conclusions, they will continue to be relegated to the background today and in the future.

Here is a (quad-historical) table summarizing the distribution of generational evidence indicating paradigm shifts:

Preliminary evidence	**First generation evidence**	**Intermediate-double evidence**	**Second generation evidence**
1. the confession of the accused (confession as "the queen of evidence", regina probationum, torture, divine	1. clue (including fingerprints, footprints, footwear, tools, weapons, and vehicle	1. neutron activation method (for examining residues) 2. speech and voice	1. DNA identification, 2. biometric identifications (biometric scans): 3. biometric scanning is often used at airports, offices, and protected institutions, 4. digital voice recognition, 5. data from public digital camera

judgment, ordeal, ordeal with fire and water) 2. testimonies	prints), 2. material remain tests (blood-related serology, hair, textile fibers, toxins, paper, glass, etc.) 3. handwriting and typing tests	recognition 3. .fingerprint identification, with traditional and AFIS technology	systems and image analysis programs, 6. digital retina and iris scanning, identification, 7. application of reconstruction software (for example: computer-aided facial scene reconstruction), 8. hand geometry test 9. digital data mining, rasterization, 10. a digital GPS system that monitors the movements of criminals or those planning to commit crimes, 11. radio frequency identification (RFID), 12. secret audio-speech-image-video recordings used mainly in connection with corruption, organized crime, and terrorist acts, 13. on a mobile phone, fax machine (video recorder), computer (anything that contains a microprocessor) or its accessories (desktop PC, laptop, netbook, tablet, disks, pendrive, etc.), (Computer Forensic Evidence), 14. digital data from virtual house searches, 15. data floating on social networks (Iwiw, Facebook, Twitter, etc.), YouTube, website monitoring data, 16. data from computer data acquisitions and cyber investigations. 17. DNA identification, 18. biometric identifications (biometric scans): 19. biometric scanning is often used at airports, offices, and protected institutions, 20. digital voice recognition, 21. data from public digital camera systems and image analysis programs, 22. digital retina and iris scanning, identification, 23. application of reconstruction software (for example: computer-

			aided facial scene reconstruction), 24. hand geometry test 25. digital data mining, rasterization, 26. a digital GPS system that monitors the movements of criminals or those planning to commit crimes, 27. radio frequency identification (RFID), 28. secret audio-speech-image-video recordings used mainly in connection with corruption, organized crime, and terrorist acts, 29. data that can be stored or transmitted on a mobile phone, fax machine (video recorder), computer (anything that contains a microprocessor) or its accessories (desktop PC, laptop, netbook, tablet, disks, pendrive, etc.), (Computer Forensic Evidence), 30. digital data from virtual house searches, 31. data floating on social networks (Facebook, Twitter, etc.), YouTube, website monitoring data, 32. data from computer data acquisitions and cyber investigations.

V. The fifth milestone, the electronical data

Crossing the threshold of the 1990s, one cannot help but notice that the world around us has changed, including the arsenal of criminals and forensics. It has expanded, namely with the almost inexhaustible [52], all-encompassing mass of digital data appearing in a thousand different forms and the related detection tools. Which lead from the dark depths of the sea to the starry sky, as let's just think of the data-collecting glass fibers covering the bottom of the oceans, or the satellites orbiting in space that help determine geographical location.[53] Just as

[52] According to Tibor Vámos, we can speak of an „information ocean" on which „pirates" sail. Tibor Vámos: Information crime – nightmares and real dangers. In Interior Review, Vol. 11-12, 2002, p. 6.

[53] In the investigation into the 1994 double murder of American OJ Simpson, American authorities requested Russian surveillance footage. (The American surveillance footage did not capture any relevant images.) The Los Angeles photos sent from Moscow clearly showed the loaded SUV parked on the street in front of the victim's apartment (875 South Bundy Drive) at the time of the crime, although Simpson claimed in his defense that he

data and information have become one of the most expensive and valuable goods in the economic sphere, so too has law enforcement recognized the empirical principle recorded by us in a previous research that "every police force is worth as much as its data."[54] Of course, as much quality, relevant data as it has. By the police, as the main custodian of crime prevention in general, we also mean the investigation, the investigator, the investigating authority, and anywhere in the world, since crime prevention and crime prevention (intelligence) fact-finding is conducted everywhere.

Data is also essential for answering basic forensic questions. A new, digital form of this (an increasingly large bouquet) has emerged in the last 20-25 years, and its landmark forms are changing and expanding day by day, at an almost unfathomable speed.[55]

We have already covered the main groups of the latest second-generation digital evidence in the area of DNA[56], and now we consider the electronic evidence listed below[57] to be included (in addition to DNA typing):

a) digital voice identification,
b) public digital camera systems and image analysis programs,
c) digital retina and iris identification,
d) hand geometry examination,
e) the use of reconstruction software (for example: computer-aided facial scene reconstruction),
f) digital data mining and rasterization,
g) biometric scanning, which is also frequently used at airports, offices, and protected institutions,
h) a digital GPS system monitoring the movements of criminals or those planning to commit crimes,
i) radio frequency identification (RFID),
j) secret audio-speech-image-video recordings used mainly in connection with corruption, organized crime, and terrorist acts,
k) data that can be stored or transmitted on a mobile phone, fax machine (video recorder), computer (anything that contains a microprocessor) or its accessories (desktop PC, laptop, netbook, tablet, disks, pendrive, etc.) (Computer Forensic Evidence),
l) digital data from virtual house searches,
m) data floating on social networks (Facebook, Twitter, etc.), YouTube, website checks,
n) computer data acquisition,[58] data from cyber investigations.

Ad a) The digital technology used in crime today was originally developed for space research, but like many other inventions from high-tech industries, such as the military, it has also been transferred from space research to the toolkit of law enforcement. Digital technology offers possibilities in voice identification that were unimaginable in the use of analog technology. Since the early 1990s, even crime laboratories with larger budgets have acquired the most modern audiovisual equipment. With the appropriate audio and video

was not in the area at the time.

[54] Fenyvesi, Csaba: Police and Marketing. Carbocomp Ltd, Pécs, 1994.

[55] Casey, Eoghan: Digital Evidence and Computer Crime: Forensic Science. Computers and the Internet. Academic Press, New York, 2000.

[56] Marshall, Angus: Digital Forensics. Digital Evidence in Criminal Investigation. Wiley-Blackwell, Chichester, West Sussex, 2008.

[57] Dinant, Jean-Marc: The Long Way from Electronic Traces to Electronic Evidence. In International Review of Law Computers and Technology. Vol. 18, No. 2. July 2004, p. 173-183.

[58] For the targets of cyber investigation and the forms of "cybercrime", see: Higgins, George E.: Cybercrime: An Introduction to an Emerging Phenomenon. McGraw-Hill, Boston, 2010.

programs, they are then able to improve poor-quality security and criminal (threatening, blackmailing, ransom-seeking, derogatory, defamatory, etc.) recordings that contain important details, or to filter out the disturbing background noise of certain audio recordings, which is used to highlight the target person's voice, and occasionally even determine the location of the speech, and the type of vehicle (lorry, truck, passenger car, motorcycle, etc.) from the sound of the engine running in the background, and rarely even its type. Sometimes, sound filtering software is also used; this can be used to identify the offender's voice pattern, which can be compared with the voices of potential suspects using a computer with a special program.

Ad b) In the field of image analysis we would like to highlight that the average person living in (developed) large cities (metropolises) is, according to some estimates, caught on camera 10-20 times a day by some kind[59] of surveillance or image recording device (located in public areas, offices, business premises, motorways, airports, train and bus stations), so the movements of the potential or actual perpetrator can often be continuously analyzed by the surveillance officer and subsequently by the intelligence service. In our practical experience, most such devices produce poor-quality recordings, which is why digital forensic experts use special software to enlarge the recorded images, which filters out unnecessary distortion factors, "noise", and also sharply reproduces the details of the enlarged image.[60]

Ad c) We will highlight a non-criminal example (but it could have been) of iris identification as an illustration. In 1995, Steve McCurry's photo of a young Afghan refugee woman with bright green eyes appeared on the cover of National Geographic. 17 years later, in 2002, he searched for the woman living in the Tora Bora area, but the subject he thought he had found had changed considerably, aged, and was almost unrecognizable. To be sure, a New Jersey company specializing in this field performed an iris comparison and established a match. Sharbat Gula was identified based on her earlier and 2002 photos.[61]

Ad d) In the biometric approach to handwriting, it is possible to extract and filter out those writing characteristics that are unique to the handwriting writer. From the data on the writing parameters, a specific pattern can be compiled, unique to the individual, the sought-after writer,[62] which facilitates and enables unique identification among potential (considerable) writers.

Ad e) The forensic application of so-called reconstruction software is diverse. It is possible to model an imaginary, we can say hypothetical original state and sequence of events from the data of the scene, which is good if at the end of the process the program finds the relevant clues and material remains, material evidence where the on-site inspection committee also found them. If this is not the case, then either the data was inaccurate and needs to be checked or the conclusion must be drawn that the hypothesis set up is incorrect and another version must be sought.

The newest digital-based achievement of reconstruction technology is[63] the technology of skull and face shaping.[64] The former can be successful even if the entire skull is not

[59] In June 2013, after five years of investigation, a German shooter was caught using digital data. As it turned out during the investigation, he was driving his truck and using a total of seven hundred and fifty 9 mm pistol bullets to terrorize people on the highway, especially drivers of trailers transporting cars. Finally, highway camera footage from five provinces was compared and, based on a systematic comparison of the recorded license plates, it was possible to identify (filter out, "extract") the only truck that matched the time and place.)

[60] Casey, Eoghan: Handbook of Computer Crime Investigation: Forensic Tools and Technology. Academic Press, New York, 2001.

[61] Salecl, Renata: Perversion and Forensic Science: Fraudulent Testimonies. In Social Research, Vol. 78, No. 3, 2011, p. 887-907.

[62] Agárdi, Tamás: New possibilities of handwriting examination and handwriting (personal) identification in the justice system. In Law Enforcement Review, Vol. 6, 2007, p. 53.

[63] The pioneer of facial reconstruction is considered to be Mikhail Gerasimov (1907-1970), a Russian anthropologist who measured soft tissue thickness during autopsies at a clinic in Moscow and then performed the first reconstructions in Irkutsk in the 1920s. He assisted in criminal proceedings in a Leningrad case in 1939. He

available. For this, the existing pieces are fitted together, like a three-dimensional puzzle. The mold can then be made, which provides the sculptor with a solid skeleton. Tiny pins (pegs) are attached to the most important points – obtained as a result of millions of autopsies and ultrasound examinations, adjusted to the species, age and gender and corresponding to the average data already published – are used to model the thickness of the soft tissues, and the filling material (rubber, wax, plaster, clay, etc.) is applied evenly accordingly, and then the contours of the face are worked out.[65] After that, the proportions are finalized and the precise placement of the details is carried out, according to certain anatomical principles (for example, the width of the nose is equal to the distance between the two eyes). When the head is ready and the glass eyes have been inserted into the eye sockets, a plaster cast is made, which is painted skin-colored, and then (with some imagination) the mouth and eyes are given their final shade.

Digital facial reconstruction works on a similar principle to that of the skull, but the bulk of the work is done here not by the creative shaper, but by a computer powered by intelligent software. After the available skull has been scanned from all angles with a special monitor, a three-dimensional image is created from the data obtained. The nails or pins used in the previously presented method are placed on this. At this point, the (artificial) skin is also applied, the sample for which is taken from previously scanned subjects. This ensures that the image does not show a featureless face, but that the individual features also appear on it. The image of the computer layer recording is carefully adjusted to the skull, in the same way as when a thin latex mask is smoothed onto the actor's face.

A photo of a living person of the same race, age, and sex is used to determine skin color, and eye color is looked up from a database that contains all possible combinations of shapes and colors. Finally, the hair is colored digitally, but in the simplest way possible. The programmer also adds some shadow effects to create a photo-like image that helps recognition as much as possible.[66]

Ad f) The essence of raster investigation was formulated by the investigative authorities of the Federal Republic of Germany in the 1970s, and since then they have been using the “Rasterfahndung” based on the comparison of information obtained from databases (connection search). In essence, it is the automated comparison of various personal and material data files with the aim of shedding light on potential or actual perpetrators and their actions, filtering them out, systematizing them, and grouping them so that persons and actions “get caught in the stretched net.”[67]

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was also given a historical assignment when he identified the skeletal remains of Timor Lenk in Uzbekistan in 1941. Exactly 50 years later, in 1991, Englishman Robin Richards developed the laser scanning (reconstruction) technique of the skull.

[64] Aulsebrook, WA. – Iscan, MY. – Slabbert, J. – Becker, P.: Superimposition and reconstruction in forensic facial identification: a survey. Forensic Science International 1995/75; Ishi, Masuko – Yayama, Kazuhiro – Motani, Hisako – Sakuma, Ayaka – Yashima, Daisuke – Hayakawa, Mutumi – Yamamoto, Seiji – Iwase, Hirotaro: Application of Superimpositon-Based Personal Identification Using Skull Computed Tomography Images. In Journal of Forensic Sciences, Vol. 56, 2011/4, 960-966. Miyasaka, S.: Progress in facial reconstruction technology. In Forensic Science Review, No. 11, 1999, 51.

[65] Hwang, Hyeon-Shik – Park, Myoung-Kyu – Lee, Won-Joon – Cho, Jin-Hyoung – Kim, Byung-Kuk – Wilkinson, Carolina M.: Facial Soft Tissue Thickness Database for Craniofacial Reconstruction in Korean Adults. In Journal of Forensic Science, Vol. 57, No. 6, 2012, p. 1442-1447.

[66] Quatrehomme, G. – Iscan, MY: Computerized Facial Reconstruction. In Siegel, J. – Saukko, PJ. – Knupfer, GC. (ed.) In Encyclopedia of Forensic Sciences. Vol. 2, Academic Press, San Diego, 2000, p. 773-778.

[67] The term der Raster means “the grid.” The father of raster investigation is Horst Herold, former head of the BKA. This investigative methodology was brought to life by terrorist acts (RAF) that seriously threatened the public security of the Federal Republic of Germany. Schenk, Dieter: Der Chef. Horst Herold und das BKA. Spiegel-Buchverlag, Hamburg, 1998.

Nowadays, digital data forms the basis of search databases, and is stored in high-performance computers[68] and used with the help of dizzyingly fast programs[69] to search for correlations for crime prevention and detection in a significant part of modern and developed countries.

Ad g) Biometric scanning, which is often used in airports, offices, and protected institutions,[70] serves both crime prevention and detection. We can also talk about digital scanning of fingerprints recorded at the scene since the ‘90s. Thus, by transmitting to the central database an image recorded at the scene of the unknown perpetrator and then scanned,[71] we can receive data on a match, on a specific person, almost simultaneously with the primary, urgent investigative actions. Just like in earprint and fingerprint identification examinations, biometric scanning is also used.[72]

Ad h-i) The digital GPS system and radio frequency identification (RFID) that monitors the movements of criminals or those planning to commit crimes are excellent tools for modeling, simultaneous and subsequent verification of the movements of perpetrators (victims) (with or without a vehicle) in both pre-criminal, criminal and finally post-criminal situations.

Ad j) Secret audio, speech, image and video recordings used mainly in connection with corruption, organised crime and terrorist acts, which are increasingly a “conditio sine qua non” for certain investigations and the methodology of certain crimes. Without them, modern law enforcement can no longer survive, as they provide law enforcement officers and the authorities assessing crimes with information (evidence) whose weight, value and credibility are very high, and whose content counter-evidence encounters fundamental difficulties on the part of the party entitled to defend itself (the defence).

Ad k-n) We have intentionally placed the mobile phone-computer-virtual house search-world wide web-cyber investigation points at the end of the list, since they can be collectively called computer evidence gathering and investigation. These deserve a more detailed explanation due to their particular importance, frequency, effectiveness, and, in summary, their “milestone” nature.

In light of this, we can say that in the 21st century, the needs of law enforcement are also changing, as many traditional crimes are committed using increasingly advanced technological methods, especially those related to finance and trade. Paper-based clues have been replaced by electronic clues. Every day, crimes and abuses related to data theft, data piracy[73] and data manipulation (child and adult pornography[74]) are revealed, both within and outside the country, occasionally on a global scale. For example, eavesdropping, surveillance (and leaking) scandals between and within countries that have caused international repercussions, as well as hacker and cracker (+data fishing or data dredging) attacks against computer technology, factory control, (even nuclear) power plant centers.

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[68] In June 2013, the world’s most powerful, high-performance computer was unveiled in China. The Tienho-2 supercomputer operates at a speed of 33.86 petaflops per second, or 33,860 trillion operations in a single second.

[69] Bequai, August: How to Prevent Computer Crime. Wiley-Blackwell, New York, 1983.

[70] In June 2013, a three-dimensional body scanner was presented at the Hungarian Innovation TechShow.

[71] Woodward, J. D. – Orlans, N. M. – Higgins, P. T.: Biometrics, McGraw-Hill/Osborne, New York, 2003.

[72] Cameriere, Roberto – DeAngelis, Danilo – Ferrante, Luigi: Ear Identification. A Pilot Study. In Journal of Forensic Sciences. Vol. 56, No. 4, 2011, p. 1010-1014. he.; Burge, M. – Burger, W.: Ear biometrics. In Jain, Anil – Bolle, Ruud – Pankant, Sharath (ed.): Biometrics: person identification in a networked society. Kluwer Academic, Norwell, MA., 1998, p. 273-286. he.

[73] Moore, Robert – McMullan, Elizabeth C.: Neutralizations and Rationalizations of Digital Piracy. A Qualitative Analysis of University Students. In International Journal of Cyber Criminalistics, Vol. 3, 2010, p. 441-451. he.

[74] Monique Ferraro, M. – Casey, E.: Investigating Child Exploitation and Pornography: The Internet, Law and Forensic Science, Academic Press, New York, 2004.

Violent crimes have not been left untouched either, they are also affected by the development of information technology. Instead of a truck bomb, the Internet can also be the starting point for serious and costly criminal (terrorist) acts. For two decades, the series' murderous diary has been kept on a floppy disk or hard drive, on a pen drive, or in the calendar of a mobile phone instead of paper and a notebook.

Just as the economic sphere has gradually shifted from product production to information production and processing, criminal activity has largely shifted from the physical dimension – in which evidence is tangible – to the virtual dimension. In this space, evidence now exists only electronically, cannot be touched, and investigations are conducted online.[75] We can also say that the transition of criminals from the first dimension to the second dimension was followed by a similar step in crime prevention, in which second-dimensional evidence became more valuable. In contrast to traditional physical traces, there are no clues or material remains in the traditional (classical) sense in computer data repositories during communication between computers, here data and data residues can be examined by forensic IT specialists with special knowledge, "online investigators."[76] Forensic informatics, which forms the basis of their knowledge, was also created to provide a solution to the specific and explicit need of law enforcement to make the most of this new form of evidence, electronic evidence (digital evidence). In essence, it deals with the acquisition, preservation, retrieval and presentation of data processed electronically and stored on a computer device.[77]

Forensic informatics differs from traditional criminal investigation fields in several aspects.

The first distinguishing feature is that both the computer material under investigation and the techniques available to the analyst are products of the market-driven private sector. In addition, unlike traditional forensic science analysis, forensic informatics usually requires that the computer investigation be conducted in any physical location, not just in controlled laboratory conditions. Instead of drawing interpretive conclusions, which characterizes many branches of forensic science, forensic informatics provides direct information and data that may be of significance to the relevant facts of the case.

Thirdly, there is a difference in that traditional forensic analysis can be controlled in a laboratory setting and can be performed logically, differentially and in accordance with widely accepted forensic science practice. In contrast, forensic informatics is almost entirely under the influence of technology and the market, usually does not take place in a laboratory setting and the analysis is almost always unique to each situation.

Fourth, a notable difference is that forensic informatics does not make interpretive statements regarding the accuracy, reliability, or discriminatory power of specific data or information.

Fifth, we can also see that traditional forensic science investigations, such as DNA testing of blood found at a crime scene, consist of a series of routine and standard steps that can be repeated from case to case. However, in the case of computer evidence, we cannot generally speak of generic (species-specific) routine procedures. There are (probably) significant differences between digital data, for which an individual investigation plan must be tailored to ensure reliability.

[75] For more information on the special "on-site" investigation technique, see the publication of the US Department of Justice: Electronic Crime Scene Investigation: A Guide for First Responders. Washington DC., 2008, and Vacca, John R.: Computer Forensics: Computer Crime Investigation. Charles River Media, Hingham, MA, 2002.

[76] Marshall, Angus M. – Tompsett, Brian C.: Identity theft in an online world. In Computer Law and Security Report, Vol 21, No. 2, 2005, p. 128-137.

[77] Damm, Matthias: I know what you saved last summer! – the use of secret spy software by crime investigators. BILETA Conference, 2008.

About digital data as a forensic milestone, we summarize – not exhaustively – in points, what is the novum in it and what facts strengthen its epochal significance.

a) The role of data that can be extracted (filtered) from computers and other digital sources in law enforcement, and let's add, crime prevention, is gaining increasing ground worldwide.

b) Data acquisition is based on very high-tech technology.

c) The courts, as the ultimate custodians of evidence, expect more information rather than more tools.

d) Forensic informatics related to digital data must take into account the fact that this field is primarily market-driven, and consequently must adapt very quickly to new products and inventions, by developing valid and reliable examination and analysis techniques.

e) It is also characteristic that forensic IT protocols are structured hierarchically so that general principles remain constant. At the same time, they are flexible in developing investigation techniques related to computer systems. This approach to forensic IT protocols may differ from the protocol approaches developed by traditional forensic sciences, but it allows for unique forensic scientific investigation.

Finally, as a conclusion to our study, we can say that the present paper, especially its second part, clearly shows that the "craftsmen-like" forensics typical of the 19^{th} century ended in the 20^{th} century. In the 21^{st} century, Morris rightly states that "craftsmen-like" detective work is a thing of the past, but the professional (investigative) goals are unchanged and can only be achieved through lifelong, continuous development and learning.[78] This message is also addressed to today's forensic scientists – including ourselves.

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[78] Literally in English: "The craft/artisan days of the detective may be over but the goal of professionalization is not to be regarded as attainable and finite. Rather, it is in each lifetime a journey of constant improvement." Morris, Bob: History of criminal investigation. In Newburn, Tim – Williamson, Tom – Wright, Alan: Handbook of Criminal Investigation. Willan Publishing, London, (USA, Canada), Vol. 36, 2008.

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