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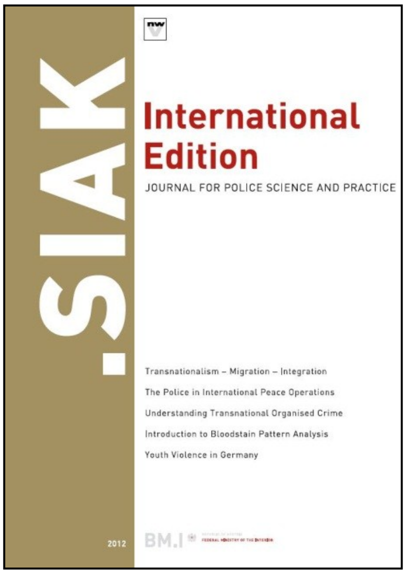

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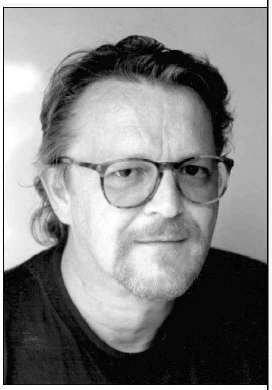
Does "Forensic Science" Exist?

Scientific Background of Criminal Investigations



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Forensic work normally covers individual crimes, unlike criminology, which investigates the general aspects of criminal behaviour. The concept of "forensic science" does not concur with the criteria of scientific research. Clearly, forensic methods are required to be well established, standardised and undisputed as much as possible. Innovation and creativity have to be severely restricted for the sake of fairness. Nonetheless, the scientific principles of objectivity, reliability and validity also apply to forensic investigations. The crucial aspects are the highest possible quality of both the investigation itself and the qualification of the expert. Genuine scientific research has inherent quality assessment mechanisms such as the "peer review" process. Additionally, mistakes are usually corrected later, by more detailed research. Correction mechanisms such as an appeals procedure or second expertise exist in forensic matters too, but the immediate impact of the results on the persons involved places the highest demands for qualification and quality. In gaining knowledge in forensic investigations, specific questions are normally followed by the generation of theories. These theories may then potentially be absorbed into the corpus of formal knowledge. Important innovations or improvements of existing techniques are often primarily based on a practical criminalist's experience and not on academic research. The latter, however, is responsible for implementing scientific rules into forensic work. This calls for a close collaboration between academic research and practical application – i.e., an enhancement of scientific input.[1]

Many popular TV series, books and films display the image of a scientist, even better a female scientist, who solves an apparently "unsolvable" criminal case by applying modern technical methods. As in other media creations, the reality content of such stories varies considerably. This is certainly legitimate, as these are products of the entertainment industry and not science formats.

It is equally legitimate to ask whether such scientists exist, whether they follow scientific premises and how strongly their work influences public life.

Let us therefore ask the seven "classical" criminalist questions: Quis? Quid? Ubi? Quibus auxiliis? Cur? Quomodo? Quando? (Who? What? Where? With what? Why? How? When?)

WHO?

The question why a young scientist might choose the field of forensics would go beyond the scope of this article. Most likely, however, it is not the prospective scientific curriculum. Many factors influence the choice of a specific professional career, scientific ambition being only one of them.

Beyond the mere number of published papers, the "impact factor" is a central parameter for quality assessment of a scientists output. This factor is mainly derived from the frequency of citations of a given scientific journal in other studies. It therefore ranks the "importance" of a journal in a specific field. This and other bibliometric indices that are often derived from the impact factor are frequently used as a means to measure the quality of an individual's scientific output, at least in the bio-medical disciplines.

Prospective "forensic" scientists can – at their best – publish in the highest rated international forensic journal (Forensic Science International), thus generating an impact factor of 1.864 (2008 – Thomson Reuters Journal Citation Reports 2009). This, however, would set her or him behind peers from related fields in all future evaluations, grant applications, project proposals, job interviews, tenure track positions etc. For example, "ordinary" papers in molecular biology (DNA screening) show much higher ratings (e.g., Journal of Molecular Biology = 4.146). The same holds for publications of chemical (e.g., Analytica Chimica Acta = 3.146), physical (e.g., Applied Physics Letters = 4.207) or psychological studies (e.g., Acta Psychologica = 2.155). Note that even these values are not the top of the ranking pyramid. The most highly rated journals are Science = 23.33, Nature = 27.96, Cell = 29.22 and the Annual Reviews in Immunology, with 41.059 impact points. Consequently, any young forensic expert would have to produce at least twice as much to keep up with competitors from neighbouring fields of research (see also Jones 2007).

The practical side is probably different. Scientists who are already established in their academic fields have been (and are) asked for their help in solving specific problems. A specialised investigation technique becomes economically viable only when a new method is accepted and a sufficient number of cases occurs. The initiative for forensic developments very often arises from criminal prosecutors, who confront scientists of various disciplines with their issues. This creates a demand for scientific expertise. Once this demand is formulated, the adaptation and application of scientific techniques become an issue of research. As noted above, forensic investigations may to some extent even reduce competitiveness in (academic) scientific performance. Compensation might come in the form of fees for expertise or an advertising effect from spectacular cases. Both, however, are not typical motives for research. Most scientists working in the field of forensics are probably motivated by a desire to help fight criminal actions with their expertise. Accordingly, other ethical motives rather than the pursuit of scientific knowledge may be regarded as the primary impetus for forensic work.

WHAT?

The term "forensics" implies "the application of a broad spectrum of sciences to answer questions of interest to a legal system".[2] Numerous disciplines such as psychiatry, toxicology, entomology etc. are included in this definition. A definition of "science" in this content, however, is rather difficult.

The philosophical system of "critical rationalism" (Popper 1993) is widely accepted as a theoretical basis of scientific efforts. Accordingly, convictions and hypotheses have to be constantly tested, thus approaching the objective truth by the repeated (iterative) elimination of errors. Still, "truth" itself cannot be reached (although assumed to exist).

Source: Ditrich

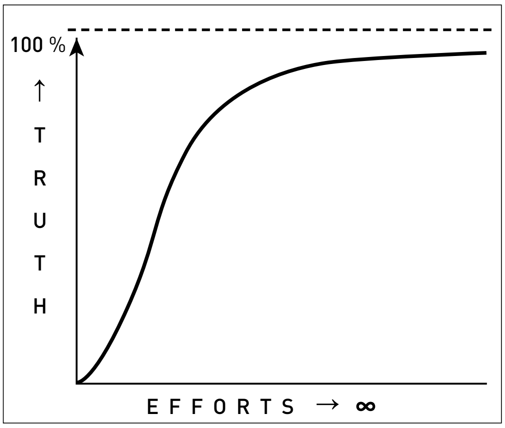

Fig. 1: Gaining insight: increasing research efforts lead to a higher degree of correctness, although absolute precision cannot be attained

The methods for testing the soundness of a theory involve mainly trial and error. If, however, a statement cannot be investigated heuristically, i.e., if it cannot be falsified, it is not an object of scientific analysis (e.g., dogmas, metaphysics etc.). Nevertheless, it is common practice in philosophy that numerous models for the explanation of understanding exist (positivism, relativism etc.).

Independently from these theoretical concepts, several criteria have been established to assess the scientific soundness of an investigation. An experiment should comply with the main criteria – objectivity, reliability and validity – to be termed "scientific" (Lienert 1989). Additional criteria, like ethical or economic considerations, are traditionally not required but are increasingly gaining practical importance.

These premises underscore that forensic work cannot fully comply with the theoretical criteria of science. Unlike in criminology, forensic examinations are normally directed at solving a specific, singular and therefore unique crime. Such investigations will normally not yield general concepts, rules and theories, unless the specific crime is generalised to an extent that a subjective category of crimes and not the singular event are the focus. Case reports are – as in a medical context – only rarely of scientific interest.

Normally, forensic investigations follow a reductive approach. First, an observation is made, then a single cause is assumed and an attempt is made to identify this single cause (e.g., crime scene – finger print – culprit). The assumption is that the observed feature is unique and can be attributed to an individual (see also Broeders 2006). Different explanation models are avoided or excluded to the extent possible (e.g., crime scene – finger print – bystander, chance, earlier contact …). Unlike this approach, a starting hypothesis in science would be refined by appropriately designed experiments (trial and error), in a classical scientific process.

WHERE?

This question seems out of context, although the discussions on this topic nearly reached the dimension of an ideological war. It seems obvious for academic researchers to conduct their work at a university, academy or research institute or the like, i.e., at an "independent" scientific organisation. This holds especially true when "basic" or non-profit research is involved.

With methods that are sufficiently established and an adequate number of cases, it may seem reasonable to form a department for forensic investigations with executive or legal officials. The potential benefits include higher efficiency and faster processing of a larger number of cases as well as better control of additional parameters such as priority setting and disciplinary intervention. At least theoretically, the lack of prejudice and bias along with the freedom from commercial pressures favour independent public officials. The monopoly of the state on juridical matters may also be a point of consideration.

The conducting of forensic investigations by private, commercially oriented enterprises was introduced during the 1980s (Thatcherism). Ironically, this was carried out under the aspect of cost reduction, even though it was mainly ideologically motivated. Without going into further details, a commercial company is by definition profit oriented. Therefore, large numbers of similar analyses, e.g. DNA-screenings, are preferred over time and labour-consuming, complex singular cases. Moreover, expenditures for materials and personnel, i.e., the costs per unit, must be minimised in order to increase turnover and profit. At the same time, private enterprises may be less prone to internal competition and to the pressure to find a culprit at all costs – a problem that is currently also being discussed in the US (Goldman 2009).

The initiatives for standardisation, quality control and certification can be viewed under these aspects. Such questions arise independently, regardless of whether the analysing institution is academic, private or state-run. Nonetheless, pressure from competitors and economic constrains affect private enterprises most strongly. Quality assurance systems, like the ISO/IEC 17025:2005 that is frequently applied in forensic labs, are designed to provide standardised solutions for – as far as possible – identical tasks and to extensively eliminate individual factors. The "European Network of Forensic Science Institutes" (ENFSI), for example, is endeavouring to implement quality standards in European forensic labs.

This quality assurance, however, can only be carried out formally – no SOP (standard operating procedure) or GLP (good laboratory practice) can be formulated for a creative process like innovation, gaining knowledge or scientific progress. Consequently, the systems are termed quality management (QM), control or assurance: their primary target is not necessarily an increase in quality. Instead, economic and efficiency issues are of central interest. Standardised processes and products (results) are not necessarily the best. Instead, the goal is minimal deviation from a (usually management or otherwise defined) target value (minimal standard). This principle is already part of the name of the Six Sigma System. Other quality systems strive for continuous improvement (EFQM, TQM), with an explicit goal of 0% errors. This target, however, can never be reached (comp. Fig. 1 – see page 42). A zero-error concept denies critical rationalism as a model of gaining information, i.e. correction of faulty hypotheses and learning from (not necessarily own) mistakes.

WITH WHAT?

The methods for forensic investigations are as various as science itself. The equipment ranges from the magnifying glass, which became emblematic for detectives, to magnetic resonance tomography. The achievable results can be separated in two groups. According to the reductionist model, only unambiguous results are possible, i.e., X is the weapon used in that crime, object Y weighs 42.7 g and person Z was at the crime scene. Indistinct statements are nearly impossible. Nonetheless, a stochastic interdependence of the results, i.e., a relative probability, is a much more frequent outcome than such an "absolute (disjoint) probability".

Similar to other skills such as typography, layout or presentation-techniques, modern statistical software has provided "mighty" tools for people in all walks of life. Mastering these techniques, however, is often coupled with several years of (often academic) education. For example, the selection of a pertinent statistical method is not trivial and requires the advice of experts.

Note in this respect that probability is the number of hits, divided by the total number of possible events (Laplace). Statistically "significant" would be an error probability of less than 5 %, "very significant" less than 1 % and "highly significant" less than 0.1 %.

Source: Ditrich

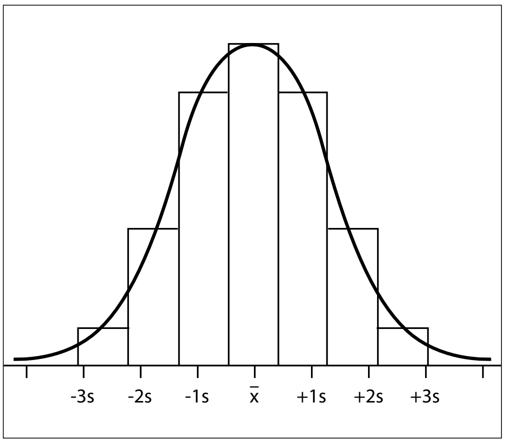

Fig. 2: Gaussian distribution: Mean (x) ± standard deviation (s) represent 68.27%, ± 2s represent 95.45%, ± 3s represent 99.73% of all possible values (hits)

Statistically "significant" (p<0.5 %) also implies that one of twenty (significant) results of an investigation is wrong (i.e., the zero-hypothesis – no connection between two incidents – is erroneously confirmed). This zero-hypothesis – a supposed correlation does not exist, a statement is wrong, a suspect is not guilty, etc. – is regarded as being true as long as the accumulated evidence does not prove the contrary. In the latter case, the alternative hypothesis – the correlation exists, a statement is true, a suspect guilty, etc. – is automatically accepted.[3] The expression "beyond reasonable doubt" is often used in courts, but lacks a statistical definition. Regrettably, an error margin of 0.0 % is a desirable, albeit unreachable goal (Fig. 1 – see page 42).

Even the highest levels of statistical significance can only prove correlations and do not provide information on causalities. Forensic reasoning is restrained – like many of us – by the induction problem. Finding that each observed swan is white implies the conviction that all swans are white. This logical mistake deduces a general rule from a number of identical observations (that may even be statistically highly significant). Unfortunately, it is not possible to gain information from a lack of knowledge by drawing logical conclusions (concluding general rules from special features). The heuristic statement "all swans are white" is valid only for those swans that already have been investigated but not for the Black Swan (Cygnus atratus).

Frequently, a more "modern" approach, the Bayes inference (Bayes theorem), has been introduced into data analysis and into forensic work alike (e.g. Steward 1996). In simplified form, this method states that the likelihood of a hypothesis being true increases proportionally with the likelihood of affirmative observations (measurements). Accordingly, a given result becomes more likely if it is confirmed by measurements and vice versa. This is certainly true in the majority of cases, but it does not circumvent the induction problem: A high likelihood that the next observed swan will be white as well still does not exclude the possibility of swans with other colours. An advantage of this method is that it is less susceptible to measurement errors because there is a feedback between the measurement and the hypothesis. Also, prior information – which is frequently available in forensic investigations – can be included in the initial hypothesis. The selection and evaluation of this initial hypothesis (the a priori likelihood) strongly influences the result, especially if relatively few data are available – a good reason to use caution in applying this method (see Biedermann et al. 2007).

Interpretations of results are often brought together in categories, sometimes to improve unsatisfactory diagnoses. Such lists (arbitrary scales) involve statements like "is very likely", "is likely", "can neither be approved nor denied", "is unlikely", "is very unlikely" (comp. Katterwe et al. 2007). They may often be useful, but are basically just aides for formulating ill-defined diagnoses that fill the range between "is" (high or very high likelihood) and "is not". Problems arise when such arbitrary scales are secondarily associated with numbers. The issue becomes even more problematic when such numbers are then associated with percent or statistical probability, and even more so if these are then used as a basis for further calculations. For example, a value in between group two (strongly indicates) and group three (indicates) in a six-part German evaluation scale would not be 2.5 but instead a subjective rating by an individual expert. The frequently demanded comparability of testimonies from different experts is only seemingly provided by a choice of (six) pre-defined diagnoses, especially when the results strongly depend on the competence of the expert.

Scientific studies normally use large samples or numbers of experiments to minimise random and systematic errors. In contrast, the number of "experiments" in forensic work is usually small. Frequently, a single event must be investigated. Such case studies – as previously noted – can be of scientific interest, provided that they cover rare incidents or allow special insights into more common events. Nevertheless, generalisations are always problematic.

WHY?

Factual evidence – confirmation of evidence by physical facts – is usually more accurate than personal evidence (testimonies, confessions etc.). In this respect, the expert's report is also considered as factual evidence, probably because a higher level of objectivity and qualification is assumed than in a witness's testimony.[4]

Even considering all of the numerous sources of error in scientific methodology, mere statements by one or more individuals are notably less precise. A pioneer of criminology, Franz von Liszt (1851–1919), already demonstrated the limitations of human memory with his famous "surprise experiment". In that experiment, an actor simulated a murder during one of Liszt's lectures, and Liszt subsequently examined the testimonies of the eye-witnesses (cf. Schneider 2002). The high number of errors prompted discussions on the value of testimonies and on interrogation techniques, discussions that continue even today (e.g., Rüßmann 1985; Smith/Ellsworth 1987). In a study of US-courts (Huff et al. 1986), 60 % of all wrong convictions were based on false testimonies (predominantly misidentifications). Furthermore, eye-witnesses cannot render the objective truth because their memory is situation-dependent. An example for such cognitive errors are "crash witnesses" – persons who hear the noise of a traffic accident, then turn to the scene and subsequently are convinced that they actually saw the crash happening. Many subjective factors strongly influence eye-witness testimony. These include the influence of a third person, previous police experience and the situation during interrogation. In addition, several psychological factors such as social background, prejudices and cognitive dissonance can yield a considerable bias. Cognitive dissonance helps to clear emotional conflicts that arise from strongly antagonistic incidents. Normally, the explanatory model that causes the least emotional conflict is regarded as "true". An example for this behaviour is the "neutralisation" of victims by criminals. This involves shifting the role of the victim ("they have only themselves to blame") or denying one's own responsibility by transformation from the culprit into a victim (of society, family situation etc.).

Despite the high demand for objectivity, experts are also susceptible to such mistakes. One dramatic example for expert prejudices are the "Worms trials" (Wormser Prozesse). In 1999 (!), these led to the formulation of minimal standards for expert evaluation of credibility by the German federal court.[5] In these investigations, several experts interrogated children about suspected sexual misconduct (and confirmed such conduct). After three major trials with all together 25 defendants, it became clear that the accusations of child abuse were fictitious and provoked by the used interrogation techniques. Prejudice from the media and public opinion had tragic consequences for the suspects as well as their children. It was never fully clarified whether the accusations were negligently, personally or ideologically motivated. The administrator of the children's home where the first allegations came from was later sentenced for child abuse.

Clearly, scientific research is also susceptible to cognitive failures, yet perhaps to a lesser extent (white mice do not lie). The "peer review" system has been established, despite occasional deficits, as a control process for the quality of scientific studies. The correctness of scientific results is – at least formally – checked by (usually) anonymous colleagues (peers) before publication in a scientific journal. It is even more important, however, that such data are subject to further (informal) examinations by subsequent research, which builds upon or extends the previous results. Accordingly, science can be regarded (within limits) as a self-regulating system.

The most important factors that generate incorrect convictions were investigated in the light of modern forensic methods. One such method is DNA analysis, which can prove the innocence of convicts, sometimes even after several years (Kamins 2009). Mistakes by authorities (police, prosecutor, jury), wrong identifications (by victim or witnesses), false results of forensic investigations, false confessions, wrong accusations (e.g., by a snitch) and mistakes in defence (lawyer) have been identified as the major causes of wrongful verdicts. This study lists incorrect forensic investigations as the third most common cause of false sentencing (after wrong identification and mistakes by the authorities). In contrast, acquittals based on faulty forensic investigations cannot be quantified. Based on its high impact on jurisprudence, the quality of forensic expertises has to be questioned.

The pertinent rules in Austria are mainly provided by the "Sachverständigen und Dolmetscher Gesetz – SDG 1975" (expert witness and interpreters law), albeit in a rather general form. The "association of generally sworn and court certified experts" supports continuous improvement of the standards of expert opinions. The qualification, competence and quality of forensic experts are also a matter of controversy in an international context. A hierarchical order of forensic personnel, ranging from "examiner" (beginner or in training) in several steps to "scientist" (leading expert), has been proposed (Pfefferli 2007; Sapir 2007; BMWA 2004). Nonetheless, the competence of expert witnesses will remain open to criticism as long as there are expert witness reports. Consequently, the only suitable correction authority is expertise from a different, more qualified expert.

Qualification, like any other resource, is subject to economic principles. The attempt to optimise the relation between efforts and effects not only pertains to quality (and quantity) of personnel but also to material prerequisites (i.e., equipment) and time for investigations. The latter is – at least theoretically – not restricted in genuine scientific research. Conversely, forensic investigations must be carried out as fast as possible to rapidly solve a criminal case.

Approaching the "truth" in a step by step experimental design (Fig. 1 – see page 42) by consciously analysing errors (or by correcting working hypotheses in forensic work) is also problematic for ethical reasons – similar to placebo treatment in pharmaceutical research. Every criminal case requires the best available solving strategy. In addition, the presumption of innocence or "in dubio pro reo" (if in doubt, in favour of the defendant) has to be followed, resulting in support of the null hypothesis.

No gain of knowledge results from this modus operandi. The relation of efforts to efficiency again follows a Gaussian curve (Fig. 3).

A small number of criminal cases requires no or only little effort to be solved. This pertains to situations in which the culprit is clear from the beginning, for example certain crimes of passion, suspects pleading guilty, caught in the act etc. In contrast, even the strongest endeavour may be unsuccessful, resulting in a "cold case". The latter, however, might be solved later as a consequence of scientific progress with newly available methods. The quantitatively largest, middle range of cases shows a direct correlation between effort and success, often following the "Pareto" principle (80 % of the work takes 20 % of the time and the 20 % remainder takes 80 % of the time). Following "economic measures", it is routinely attempted to reduce the expenses in this middle range. Nonetheless, superficially "pragmatic" or "efficiency-oriented" measures usually fail. For example: It is certainly costly to pursue small-scale crime like littering, public nuisance, vandalism, etc. Conversely, deficiencies in this respect result in numerous negative effects. Slum formation, falling real estate values, higher level crime, etc. are the consequences ("zero tolerance", comp. "broken windows" theory; Wilson/Kelling 1982). Maintaining public security and preserving communal

Source: Ditrich

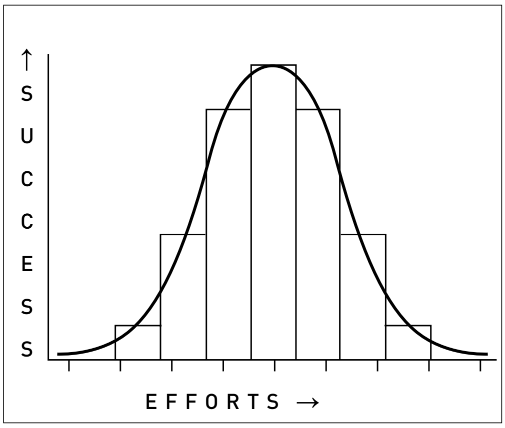

Fig. 3: Relation of efforts (personnel, money, time, know-how, ...) to solved crimes, based on limited resources

Source: Ditrich

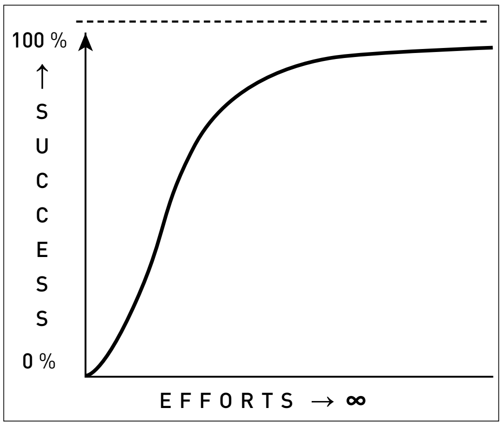

Fig. 4: Relation of efforts (personnel, money, time, know-how, ...) to solved crimes, based on unlimited resources[6]

order (and consequently the state's monopoly on the use of force) are ill-suited for economic experiments.

HOW?

The most important scientific criteria – objectivity, reliability and validity – have been already mentioned above. Clearly, the collection of forensic data should be objective. The whole procedure of collection, interpretation and evaluation of evidence has to be protected from all internal or external influences. This pertains to economic or psychological pressure and tailored reports (the psychological setting), but also to personal bias, expectations and prejudices (the psychological set). Such influences can often be avoided by double or triple-blind test designs, e.g., in pharmaceutical research. Similar precautions are taken in routine analyses such as in drug or DNA screenings. Still, investigations of complex crimes require full information and intense communication of all the involved experts. Accordingly, the demand for objectivity relies heavily on high personal ethical standards.

Reproducibility (reliability) of forensic results, i.e., being able to repeat, control and perform a (statistically) precise measurement, is unfortunately sometimes only theoretically possible. This is due less to inappropriate methods or equipment than to the nature of trace evidence. Frequently, few or even only one object are available for investigation. Such single objects are then often altered or consumed by the analysis. Many chemical methods, for example, are destructive. This prevents an independent control of the results by a second analysis. Reproducible measurements require a sufficiently large sample that has to fulfil several additional criteria (homogeneity, randomness …). In the criminalist routine, traces are normally rare, often contaminated, poorly preserved, etc. At any rate, they do not adhere to the "standard". Note that several scientific disciplines face the same problems. Historical, palaeontological or even medical objects may also be rare or unique. This in no way decreases their importance – just the contrary. A special case in forensics that practically never occurs in conventional sciences is false, i.e., manipulated traces (if this does occur in science, then often with spectacular consequences). Recognition of such fabricated evidence requires the highest qualification and experience of the investigator, as well as extensive information on all aspects of the case. These requirements, however, are contradictory to attempts at formally ensuring objectivity (double blind tests, anonymised samples).

The third main criterion for a scientifically sound investigation – validity of the results – refers to the quality of the supporting argument. A result has a high level of validity if the related question is answered to a high degree, i.e., the theory is strongly confirmed (or rejected). The optimal outcome would be a causal relationship that fully explains an observation, such as increased rates of traffic accidents with higher blood alcohol levels. The main prerequisite is that only one (the measured) parameter varies and all other factors remain constant. This can be done for example by an experimental design involving "matched pairs" – persons that differ only in the item to be investigated. This approach is clearly impossible in forensic studies. The number of parameters that influence a forensic case is usually rather high and undetermined. Following the previous example, a specific traffic accident can have many different causes besides the influence of alcohol. The ideal of a controlled environment in a laboratory cannot reflect the complexity of real life.

The qualification of an investigator and the quality of the used methods clearly determine the validity of a study. Both are largely influenced by the parameters of efficiency and expediency. Unlike scientific studies, where originality plays an important role, a novel experimental approach is normally not encouraged for forensic investigations. The high demand for quality (jury, lawyer) and the severe impact of the results on the concerned parties (suspect, victim and their families) frequently inhibit the use of techniques that are in development or are deemed less sound due to inherently higher error levels.

Juries in Austria and elsewhere in Europe have acted pragmatically in this respect. Up until 1993, the Frye standard was applied in the USA. This concept basically states that a method has to be "generally accepted" by practitioners in the respective field to be accepted in court. As this criterion turned out to be insufficient, the more substantial "Daubert standard" was introduced, following the decision of the US Supreme Court in the Daubert vs. Merell Dow Pharmaceuticals case (1993). The latter implies that, beyond acceptance by the scientific community, a method has to be published in a peer-reviewed scientific journal and it must be possible to verify or falsify the results as well as to calculate the level of error. Implementing this standard led to problems, even with already well-established methods such as fingerprint investigations (dermatoglyphics). The latter is well accepted by practitioners but has rarely been investigated scientifically. For example, it has never been proven that the evaluated features of the papillary lines are really exclusively individual and that identical fingerprint details can never be found in different persons. Probability distributions – like in DNA analysis – cannot be given for fingerprints. Note, however, that such statistical information should not be over-estimated: a probability of error of 1 in 1 million still means that seven people in Austria alone have an identical DNA pattern. Moreover, the acceptance of a given method may change with increasing scientific knowledge. For example, the chemical analysis of lead from bullets has recently been criticised as "junk science" (Cytrynbaum 2009).

In an extensive, very detailed study, the US Academy of Science (National Research Council 2009) states that the decisive importance of forensic expertises and the need for improvement of the scientific basis require the establishment of a new, independent research facility – the National Institute of Forensic Science (NIFS). A key conclusion in that study is that such an institution should promote the development of forensic methods according to scientific standards. Additionally, this institute should support or coordinate several initiatives for scientific progress, education, quality control and standardisation. The proposal to centralise forensic research in one institution may be a matter of dispute. At the same time, any initiative to advance scientific standards in forensic investigations must be appreciated.

WHEN?

Did a "forensic science" exist in the past or can a stronger impact of scientific thinking be expected for the future?

Historically, the beginning of the systematic search for forensic evidence was probably in the Age of Enlightenment, pursuing "pure science", rationality and the legality principle in justice and legal matters. This pertains especially to legal (forensic) medicine, which was promoted by reforms of the criminal laws by Joseph II (Josephina 1787) and the influence of his court-surgeon Giovanni Brambilla (1728–1800). They encouraged the use of autopsies for clarifying the causes of death. "Gerichtliche Wundarzney" (chirurgia forensis) was already taught in the second year of the medical curriculum. The first academic chair for legal medicine and medical "Polizey" in a German-speaking country was given to Ferdinand Vietz (1772–1815) at the University of Vienna in 1805. Forensic medicine in Austria culminated with the works of Eduard v. Hofmann (1837–1897), Albin Haberda (1868–1933) or Wilhelm Holczabek (1919–2001), but also Carl v. Rokitansky (1804–1878) and Richard v. Krafft-Ebing (1840–1902). The roots of Enlightenment, respectively of Josephinism can be found even today in the Austrian legal system. The international forensic reputation of Austria, however, diminished somewhat in the late 20th century.

Currently, scientific research with forensic intentions is mainly carried out at universities, with an emphasis on case studies and methodological developments. A substantial research impetus for Austria can be expected from international programmes like the 1.4 billion euro Seventh Framework Program on Security Research (CORDIS – FP7) of the EC and various other initiatives by Europol, Frontex, Cepol etc. The initiatives for establishing the National Institute of Forensic Science (NIFS) in the USA may also promote new incentives in Europe to further enhance basic research in the field of forensics.

An important objective is a continuous increase in the qualification of forensic practitioners. Due to the central position of experts and consultants in the legal system, their competency should fulfil the highest demands (critically: Schorsch 2000). Even more importantly, efforts must be made to ensure that a sufficient number of undisputed domestic experts for the wide field of forensic questions becomes available. Subpar processes in resolving a case like the train fire disaster in Kaprun (2000) can cause legal problems even after many years. While the timing of scientific research can often be planned, the chances of solving a criminal case typically decrease considerably after 48 hours. It is therefore desirable to have highly qualified investigators (with international stature) at the scene as soon as possible. Continuous and intense exchange between scientific (basic) research and forensic criminalist practice seems the most advantageous strategy to reach that target.

[1] *The author expresses his thanks to M. Stachowitsch for critical reviewing of the manuscript and to Bettina Bogner for helpful comments.*

[2] *Wikipedia: „forensics" – 25.08.2010.*

[3] *See also the verdict German BGHSt 45, 164 ff (1 StR 618/98).*

[4] *E.g., Austrian § 125 StPO; SDG 1975.*

[5] *1 StR 618/98 from 30.07.1999.*

[6] *A success rate of 100 % can be approached but never reached (saturation curve).*

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