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CHAPTER 2

HARMONIZATION OF FORENSIC EXPERT TRAINING WITH CURRENT DEVELOPMENT TRENDS IN UKRAINE AND ABROAD: DETAILED ANALYSIS AND IMPLEMENTATION PROSPECTS

ABSTRACT

Modern forensic science lies at the intersection of science, technology, and law, requiring a comprehensive approach to the training of forensic experts. The globalization of crime, digitalization, and the development of innovative research methods necessitate a fundamental reform of the expert training system in accordance with international standards.

This chapter of the monograph presents a detailed analysis of forensic expert training in leading countries, including the USA, Germany, the United Kingdom, France, Canada, Switzerland, Australia, and Poland. The authors examine existing effective training models that can be adapted for the Ukrainian system. A comparative analysis of undergraduate forensic science programs at the University of Lausanne (Switzerland) and the Educational and Scientific Institute No. 2 of the National Academy of Internal Affairs of Ukraine is presented.

The study highlights key areas for modernization, particularly the unification of educational programs. The emphasis is placed on the urgent need to adapt curricula to modern demands, including harmonization with international standards, integration of advanced knowledge on the application of innovative methods in practice (artificial intelligence, digital forensics, blockchain), and strengthening practical training based on real case studies. Furthermore, the importance of an interdisciplinary approach and expanding cooperation between universities, expert institutions, and law enforcement agencies is underlined.

KEYWORDS

Forensic science, criminalistics, expert training, international standards of expert education, artificial intelligence, blockchain, legal ethics, cooperation with law enforcement agencies, big data analysis, innovative methods, interdisciplinary approach.

In modern conditions, forensic science is a crucial element of the justice system, ensuring the objectivity and scientific validity of evidence in criminal, civil, and administrative proceedings.

Given the increasing complexity of crimes amid scientific and technological progress, particularly cybercrime, financial fraud, terrorism, and environmental offenses, there is a growing demand for a new generation of experts capable of applying, analyzing, and synthesizing innovative technologies, working with interdisciplinary data, and meeting international standards.

At the present stage of societal development, globalization, digitalization, and the increasing demands for the efficiency of justice necessitate the harmonization of forensic expert training with the best global practices in the context of constant change and improvement, along with the adaptation of Ukrainian legislation to the acquis communautaire of the European Union. In this context, the experience of leading countries serves as a benchmark for reforming Ukraine's system of forensic expert training.

The modern system of forensic expert training is in a state of continuous evolution, driven by the growing complexity of forensic tasks, technological development, and globalization. An important task is the adaptation of educational programs to current needs, including harmonization with international standards, integration of innovative technologies, and the formation of practical skills. The chapter examines the experience of Ukraine and eight leading countries in forensic expert training: the USA, Germany, the United Kingdom, France, Canada, Switzerland, Australia, and Poland.

Despite certain achievements, the Ukrainian system of forensic expert training faces numerous challenges limiting its effectiveness and competitiveness at the international level. One of the major problems is the insufficient integration of educational programs with international standards, leading to gaps in the professional knowledge and skills of experts. Modern challenges, such as the globalization of forensic research and the development of new technologies, particularly in the field of digital forensics, require forensic experts to possess not only solid theoretical knowledge but also the ability to adapt quickly and apply innovative methods in practice.

Another significant problem is the lack of practical orientation within training programs, resulting in many graduates lacking sufficient experience in dealing with real-life forensic cases and using advanced technologies, applied in forensic examinations. This limits their ability to work effectively in contemporary criminal investigations, which often require the use of complex analytical tools and technologies.

Additionally, the insufficient cooperation between educational institutions, law enforcement agencies, and international expert centers is a notable concern. In circumstances where international cooperation is a key factor in combating transnational crime, the lack of knowledge and experience exchange between countries in the field of forensic science leads to a gap between educational standards and practical requirements.

Therefore, the need to harmonize forensic expert training, considering the latest development trends, is an urgent issue for Ukraine. Solving this problem requires a comprehensive approach, including the reform of educational programs, improvement of practical training, implementation of innovative technologies, and development of international cooperation in the field of forensic science.

2.1 CURRENT STATE AND GLOBAL EXPERIENCE IN FORENSIC EXPERT TRAINING: THEORETICAL AND METHODOLOGICAL ANALYSIS

The issue of forensic expert training has been the subject of research and publications by numerous domestic and foreign scholars.

The work of M. Morelato, L. Cadola, M. Bèrubè, O. Ribaux, and S. Baechler presents a strategy for teaching and learning in forensic science, developed at the University of Lausanne (Switzerland) and adapted at the University of Technology Sydney (Australia) and the Universitè du Quèbec à Trois-Rivières (Canada) [1].

The goal of the strategy is to analyze and elaborate on real-life situations using a progressive approach to teaching and learning, which is based on theory and practical exercises, placing students in authentic scenarios.

The case-based learning approach enables students to develop or modify their existing knowledge through real-life experiences, reflective observation, active experimentation, and communication. This approach has proven more effective for achieving long-term learning outcomes and fostering a deep learning approach. It challenges students' ability to solve complex problems they are likely to encounter in the workplace.

Case studies provide structured and transversal learning material, which has been successfully adapted in various countries and contexts. This approach also shifts the educational focus from methods to reasoning processes and forms of argumentation necessary at all stages of forensic activity.

Through this innovative learning process, students move away from perceiving the Court (trial) as the sole ultimate goal of forensic science studies. They learn to perform diverse roles, adopt proactive attitudes, and work both individually and collaboratively. Such a teaching and learning strategy breaks existing isolation in forensic science by focusing on processes and critical thinking [1].

J. González-Rodríguez provided a professional review of forensic science education programs in Europe, excluding the United Kingdom and Ireland [2]. The results of his work are presented in the **Table 2.1**.

Table 2.1 Forensic science university courses in Europe (excluding UK & Ireland)

Institute/program's housing unit/ location/website	Degree & course title	Course language
1	**2**	**3**
Austria **Medical University of Vienna** Department of Forensic Medicine Forensic Molecular Biology Vienna	(In development)	German
https://www.meduniwien.ac.at/hp/fileadmin/gerichtsmedizin/DGM_Org_neu_2016/2016_05_17_Org_eng.pdf		

Continuation of Table 2.1

1	2	3
Bulgaria **Varna Free University** Department of Security and Safety Law Faculty Varna	Master: Forensic Science Expertise	Bulgarian
http://vfu.bg/en/ects_guide/fi les/uf/mag/se/ske.html		
Germany **Steinbeis College** Berlin	MA: Criminology	
http://www.fachhochschule.de/FH/Studium/Master_of_Arts_Criminal_Investigation_17738.html		
University Humbolt Berlin	(A historical well known program was closed in 1994, following the fall of the Berlin Wall. Currently, programs are offered in partnership with King's College London)	
http://www.kcl.ac.uk/study/postgraduate/taught-courses/forensic-science-msc-mres-pg-dip-pg-cert.aspx		
Bonn-Rhein-Sieg University of Applied Sciences Department of Natural Sciences Sankt Augustin	BSc: Forensic Sciences	German (50%) English (50%)
https://www.h-brs.de/en/anna/forensic-sciences-bsc		
Brandenburg University of Technology Cottbus-Senftenburg Faculty of Environment and Natural Sciences Cottbus	MSc: Forensic Sciences & Engineering	German
https://www.b-tu.de/en/study/study-programmes/detail/123-forensic-sciences-and-engineering		
Italy **Sapienza University of Roma** Faculty of Physical and Natural Sciences Rome	MSc: Forensic Analytical Method	Italian
http://www.uniroma1.it/didattica/master/2015/metodologie-analitiche-forensi-0		
University of Bologna Professional Master's Programmes Bologna	MSe: Forensic Chemical & Chemical-Toxicological Analyses	Italian
http://www.unibo.it/en/teaching/professional-master/2015-2016/forensic-chemical-and-chemical-toxicological-analyses-8638		
The Netherlands **The University of Amsterdam** Institute for Interdisciplinary Studies Graduate Schools of Sciences Amsterdam	MSe: Forensic Science	English
http://gss.uva.nl/future-msc-students/content/forensic-science.html		

Continuation of Table 2.1

1	2	3
Avans University of Applied Sciences Breda	Bachelor of Chemistry Bachelor of Biology	English & Dutch
http://www.avans.nl/international/programs/programfi nder/international-forensic-science-short-programme-breda-voltijdshort-course/introduction		
Portugal **The University of Coimbra** Faculty of Medicine Rua Larga, Coimbra	Master: Legal Medicine & Forensic Science	Portuguese
https://apps.uc.pt/courses/en/course/1392		
Instituto Superior de Ciências da Saúde Egas Moniz Higher Health Sciences Egas Moniz Institute Lisbon	BA: Forensic & Criminal Sciences	Portuguese
http://www.egasmoniz.com.pt/pt-pt/ensina/iscsem/cursas/licenciaturas/licenciatura-em-ciências-forenses-e-criminais.aspx		
Spain **The Autonomous University of Barcelona** Graduate School Cerdanyola del Vallès, Barcelona	Master: Criminology – Forensic Sciencea Graduate Diploma: Criminalistcsb Forensic Science & Criminal Intelligencec Forensic Handwritting Analysisd	Spanish
[a]http://www.uab.cat/web/postgraduate/master-in-criminology/general-information-1217916968009.html/param1-1487_en/param2-2014/ *[b]http://www.uab.cat/web/postgraduate/graduate-diploma-in-criminalistics-analysis-of-information-and-advancedtechniques-in-forensic-sciences/general-information-1217916968009.html/param1-1471_en/param2-2014/* *[c]http://www.uab.cat/web/postgraduate/graduate-diploma-in-forensic-science-and-criminal-intelligence/generalinformation-1217916968009.html/param1-3002_en/param2-2014/* *[d]http://www.uab.cat/web/postgraduate/graduate-diploma-in-forensic-handwriting-analysis/generalinformation-1217916968009.html/param1-3058_en/param2-2013/*		
The University of Alcalá Spanish University Research Institute of Police Sciences Faculty of Law Alcalá de Henares, Madrid	Master: Police Sciencea PhD: Forensic Scienceb	Spanish
[a]https://www.uah.es/es/estudios/estudios-oficiales/masteres-universitarios/Ciencias-Policiales/ *[b]https://www.uah.es/es/estudios/estudios-oficiales/doctorados/Ciencias-Forenses-D412/*		
University of Murcia Faculty of Biology Espinardo Campus Murcia	Master: Forensic Sciences	Spanish
http://www.um.es/web/biologia/contenido/estudios/masteres/ciencias-forenses		

Continuation of Table 2.1

1	2	3
University of the Basque Country Master and Doctoral School	Master: Forensic Analysis	Spanish/Basque
http://www.ehu.eus/en/web/masteranalisisforense/aurkezpena		
University of Valencia Department of Preventive Medicine Valencia	Master: Forensic Science	Spanish
http://formacion.adeituv.es/ciencias-forenses/#		
Pablo de Olavide University Social and Legal Sciences Seville	Master: Criminology & Forensic Science	Spanish
https://www.upo.es/postgrado/Master-Ofi cial-Criminologia-y-Ciencias-Forenses		
Sweden **The University of Uppsala** Faculty of Medicine Uppsala	MSe: Forensic Science	Swedish
http://www.uu.se/en/admissions/master/selma/program/?pKod=MFV2M&lasar=16/17		
Switzerland **The University of Lausanne** Batiment BCH Lausanne	BSe: Forensie Seience[a] MSe: Physical Identification[b] Chemical Criminalistics[c] Traceology & Crime Analysis[d*] Digital Investigation &Identification[e] PhD: Forensic Science[f] Certificate: Essentials of Forensic Interpretation[g] Essentials of DNA Interpretation[i] Certificate of Advanced Studies: Statistics in the Interpretation of Evidence[h]	French French French French French French & others English English English
www.unil.ch/esc *[a]http://www.unil.ch/esc/bachelor* *[b]http://www.unil.ch/esc/master-id* *[c]http://www.unil.ch/esc/master-cc* *[d]http://www.unil.ch/esc/master-tracologie* *[e]http://www.unil.ch/esc/msc-investigation-numerique* *[f]http://www.unil.ch/esc/home/menuinst/doctorats-et-recherches/doctorat-en-science-forensiq.html* *[g]http://www.formation-continue-unil-epfl.ch/essentials-forensic-interpretation* *[h]http://www.formation-continue-unil-epfl.ch/statistics-evaluation-forensic-evidence-cas* *[i]http://www.formation-continue-unil-epfl .ch/essentials-dna-interpretation* *[*]With the University of Montréal, Department of Criminology*		
Turkey **Istanbul University** Institute of Forensic Sciences Cetrahpasa Kampusu Istanbul	MS: Forensic Science[a] PhD: Forensic Science[b]	Turkish Turkish
[a]http://adlitip.istanbul.edu.tr/en/ms-in-forensic-sciences/ *[b]http://adlitip.istanbul.edu.tr/en/phd-in-forensic-sciences/*		

Source: [2]

The author describes forensic science education in Europe as a "patchwork" that is difficult to unravel. In many countries, there are no studies, dedicated to forensic science education, leading to degrees being open to non-governmental professionals.

In these countries, there are connections between official, governmental, or police laboratories and academic institutions, as well as opportunities for internal education leading to academic status. In many European countries, forensic activities and research may be conducted at departments of forensic medicine without conferring a scientific degree, except for medical specialization.

Many countries also offer forensic science courses to law students or as part of criminology programs. Finally, there is a network of universities claiming to offer forensic science degrees, which are mostly delivered remotely [2].

In the work, dedicated to forensic expert training [3], authors S. Grey and B. Swanston made key conclusions that forensic science education can prepare students for various careers in the field, including work as forensic anthropologists, criminal investigators, forensic scientists, and forensic toxicologists. It is noted that many positions in this field require certification by one of the numerous specialized organizations responsible for the accreditation of forensic experts [3].

The issue of an optimal model and mechanism for forensic expert training to enhance their professional level and advance the field to a qualitatively new stage has been addressed by scholars V. Alekseichuk and I. Starodubov [4]. In their view, in most cases, obtaining the qualification of a forensic expert requires comprehensive higher education. For example, for the specialization "Economic Research in the Field of Intellectual Property", in addition to majoring in 076 "Entrepreneurship, Trade, and Stock Exchange Activity" or 081 "Law", specialists should preferably have higher education in one of the following fields within the knowledge area 0305 "Economics and Enterprise": 051 "Economics", 056 "International Economic Relations", 072 "Finance, Banking, and Insurance", or 071 "Accounting and Taxation". At the same time, to conduct, for instance, an objective examination of an invention, the expert must have a technical education; for the analysis of computer programs – education in computer science; and for conducting economic research – an economic background, and so forth [4].

2.2 THEORETICAL AND METHODOLOGICAL FOUNDATIONS AND CURRENT TRENDS IN FORENSIC EXPERT TRAINING IN GLOBAL PRACTICE

Any forensic examination is an applied scientific study of objects, conducted in accordance with rules, determined by the specifics of its subject and the scope of information necessary for its performance, drawn from relevant fields of science and technology.

The objects of forensic examinations, in a broad sense, may include substances, materials, industrial and other products, technologies, works of art, plants, animals, human beings, documents, and more. The goals and tasks of forensic examinations are determined by the area of human activity, within which they are conducted.

Forensic examination is a specific type of expert activity with a special legal status.

The essence of forensic examination lies in the analysis, upon the assignment of an individual or authority conducting legal proceedings, of material objects (physical evidence) and various documents by a qualified person (expert) with the purpose of establishing factual data relevant to the correct resolution of the case.

Upon the completion of the examination, the expert issues an expert opinion, which, according to law, is one of the sources of evidence, and the factual data contained therein constitute proof.

According to the current legislation of Ukraine, the key bearer of specialized knowledge is the forensic expert, who applies such knowledge both in procedural form – when its results have evidentiary value – and in non-procedural form.

The only formal requirement for an individual to act as a forensic expert under Ukrainian law is the possession of specialized knowledge.

The concept of "specialized knowledge" is not legally defined. In academic literature, it is traditionally understood as a system of theoretical knowledge and practical skills in a particular field of science, technology, art, or craft, acquired through special training or professional experience, necessary for solving questions arising in the course of criminal or civil proceedings. Commonly known and legal knowledge is not considered specialized.

However, in today's conditions, new achievements of rapidly developing science, technology, and emerging disciplines are continuously integrated into forensic practice.

In our view, these developments inevitably cause a transformation of the concept of "specialized knowledge". The boundaries of the expert's and specialist's competence, as well as the very necessity of their involvement in a case, directly depend on the meaning attributed to this term. Therefore, this issue is not merely academic but has serious practical significance.

The relationship between specialized and commonly known knowledge is inherently variable and depends on the level of societal development and the extent, to which scientific knowledge is integrated into everyday life. As knowledge of a particular phenomenon, process, or object expands and deepens, it becomes increasingly differentiated, systematic, and accessible to a wider audience. As a result, the sphere of everyday knowledge is enriched.

Returning to the question of who may act as forensic experts under Ukrainian law, such individuals are those who possess the necessary knowledge to provide opinions on specific issues under investigation.

The professional and qualification requirements for forensic experts, employed in state specialized institutions or working independently, are outlined in Article 10 of the Law of Ukraine "On Forensic Examination" dated 25.02.1994, No. 4038-XII [5]. The law stipulates that positions of experts in state forensic institutions may be held by professionals with relevant higher education, a qualification level of at least "specialist", who have completed appropriate training and obtained the qualification of forensic expert in a specific specialty.

In Ukraine, academic training of forensic experts is primarily conducted on the basis of legal and technical universities, among which the leading institutions are:

– The National Academy of Internal Affairs – Educational and Scientific Institute No. 2 is currently the only institution that offers training for applicants with an expert-criminalistic focus. It provides training for master's degree seekers in the specialty "Law" with a specialization in "Forensic Examination";

– Taras Shevchenko National University of Kyiv – offers specialized courses in criminalistics and forensic examination, including DNA analysis and trace evidence examination;

– Kharkiv National University of Internal Affairs – provides courses in digital forensics and ballistics;

– Odesa State University of Internal Affairs – specializes in handwriting examination and forensic anthropology.

Let us briefly examine the state of forensic expert training in some foreign countries.

United States

The U.S. system of forensic expert training is one of the most advanced globally. It is based on cooperation between universities and law enforcement agencies. The FBI Academy offers programs in criminalistics, forensic medicine, and digital forensics.

A strong emphasis is placed on practical training. Students undergo internships in laboratories and participate in real criminal investigations.

In terms of innovation, the U.S. actively utilizes automated systems for evidence analysis, such as the CODIS DNA database and the IAFIS fingerprint database.

However, forensic scientists are often confused with crime scene investigators, although these two professions differ significantly (**Table 2.2**) [6–8]. They require different qualifications, have distinct work characteristics, and employ different technologies [9, 10].

Table 2.2 Main differences between forensic experts and crime scene investigators

Forensic science	Crime scene investigator (CSI)
A significant portion of the work is done in laboratories, where forensic data is collected and analyzed based on evidence collected during crime scene examinations	A large part of the job involves visiting and analyzing crime scenes
To work in this field, forensic scientists typically must have at least a bachelor's degree	While a degree in forensics or other science is desirable, forensic investigators can also start their careers as police officers and then move up to the position of forensic investigator
There are many opportunities for experts to specialize in a wide variety of fields	Crime scene work does not allow for many specializations, although the skills learned can be applied to other positions, such as working in government organizations

Source: [6]

Forensic experts are well-paid professionals with significant career opportunities. In fact, employment in forensic science is projected to grow by 13% by 2032, much faster than the national average.

Germany

In Germany, forensic expert training is decentralized. Each federal state has its own educational programs, tailored to regional needs. The system is characterized by narrow specialization, covering such areas as toxicology, ballistics, handwriting analysis, etc. Continuous cooperation with research centers is common. For example, the Max Planck Institute for Criminal Law is a leading institution in developing innovative analysis methods.

United Kingdom

In the UK, it is advisable to choose a course, accredited by the Chartered Society of Forensic Sciences (CSFS) for those wishing to obtain a degree in forensic science. One may earn a degree directly in forensic science or in a related discipline (e.g., chemistry, biology, medical sciences, or physics) and later apply for forensic positions. Postgraduate qualifications in forensic science or related subjects are also available.

The British system emphasizes ethics and interdisciplinarity. Cranfield University offers courses on evidence analysis, DNA processing, and digital data examination. Collaboration with the police plays an important role, enabling students to work with real evidence.

France

The French Institute of Forensic Sciences in Lyon is one of the leading centers for expert training. Programs include internships in laboratories, working on real cases, and using modern equipment for toxicological and biological data analysis.

Canada

Canadian universities, particularly the University of Toronto, integrate innovative technologies into their programs. Students study artificial intelligence, blockchain, and cybersecurity, which is increasingly relevant given the rise in cybercrime.

Australia

Australian universities, such as the University of Melbourne, focus on international standards. Programs include evidence analysis using modern technologies and the study of international law for addressing transnational crimes.

Poland

In Poland, the Central Forensic Laboratory cooperates actively with universities. Students study spectrometry, forensic anthropology, and DNA analysis techniques.

The analysis of international forensic practice shows that a higher education degree alone is not sufficient for a forensic expert [11–15]. The emergence of new technologies creates both opportunities and challenges for forensic experts, changing methods of research and evidence analysis.

Artificial Intelligence (AI) plays an increasingly important role in modern society. AI technologies have been integrated into navigation, smartphone applications, advertising, smart homes and vehicles, finance, etc. Terms such as “digital economy”, “digital school”, and “digital forensics” have become commonplace [16].

The AI field is developing rapidly, undergoing significant changes daily, constituting a true technological revolution. Alongside obvious advantages and conveniences, AI technologies give rise to

new types of crime and present serious challenges for law enforcement worldwide. For forensic science, this means an expansion of research objects and the need to adapt to new realities [16].

Since its inception, forensic science, as both a scientific and practical discipline, has continuously incorporated the most advanced and effective research methods available at the time.

Modern AI algorithms are capable of processing vast amounts of data, including surveillance footage, digital evidence, or biological samples. They can identify patterns and anomalies, often overlooked by human analysts. Moreover, machine learning techniques enable the automation and optimization of processes, such as fingerprint analysis, ballistics examination, and DNA profiling. This significantly increases the accuracy of research and reduces the risk of human error.

Another technological breakthrough affecting forensic science is the use of advanced visualization methods. Thanks to 3D scanning, modeling, virtual reality (VR), and high-precision microscopy, experts achieve an unprecedented level of detail in analyzing evidence and crime scenes [17].

Forensic science is undergoing a significant transformation due to technological advancements. For instance, 3D scanning enables the creation of highly accurate digital replicas of crime scenes, allowing investigators to examine them from different perspectives and analyze spatial characteristics. VR technologies immerse investigators in virtual reconstructions of events, facilitating a better understanding of object positioning and event dynamics [17].

Additionally, modern microscopy methods, such as scanning electron microscopy (SEM) and atomic force microscopy (AFM), enable forensic experts to examine evidence at the nanoscale. This capability reveals details that would be inaccessible through traditional microscopes, significantly expanding the scope of forensic examinations.

Furthermore, the integration of blockchain technology into forensic practice is being discussed in professional circles as a means to enhance data integrity and transparency, ensuring authenticity and immutability of records.

In forensic science, the reliability of evidence can be compromised by frequent issues, associated with traditional evidence management systems, including data manipulation, unauthorized access, and a lack of transparency. Blockchain technology has emerged as a viable approach to addressing these challenges by offering a decentralized, transparent, and immutable framework for data management [18–20].

By creating an immutable and decentralized record of evidence movement and analysis, blockchain technology can help mitigate the risk of tampering or misuse, further strengthening the credibility of forensic investigations as a source of proof. Some existing systems may face difficulties in handling large volumes of evidence or adapting to the increasing complexity of legal cases [18, 19].

Many traditional systems rely on centralized databases, making them vulnerable to hacking, unauthorized access, and data manipulation. These systems may also lack robust security measures to protect confidential information. Without advanced encryption and access controls, the risk of data breaches and unauthorized disclosure of evidence remains high.

However, the adoption of these new technologies in forensic science is not without challenges. Issues related to data privacy, cybersecurity, and the potential for misuse or over-reliance on these

technologies must be carefully examined and addressed. Moreover, forensic experts will need specialized training and education to effectively utilize these new tools and methodologies.

As the field of forensic science continues to evolve, it is crucial for practitioners and researchers to stay informed about emerging technologies and their potential applications. By embracing innovation while maintaining a commitment to scientific rigor and ethical principles, forensic experts can harness the power of these technologies to enhance the accuracy, efficiency, and reliability of their work, ultimately strengthening the pursuit of justice and public safety.

The conducted analysis indicates a growing demand for highly skilled professionals in the analysis and interpretation of evidence.

In our opinion, the emergence of new technologies and methodologies encourages forensic practitioners to acquire new knowledge, skills, and qualifications necessary to meet the challenges they face.

2.3 THE SYSTEM OF FORENSIC EXPERT TRAINING IN UKRAINE: CURRENT STATE, CHALLENGES, AND PROSPECTS FOR HARMONIZATION WITH GLOBAL DEVELOPMENT TRENDS

For many years and until today, forensic experts of almost all types and categories (except for specialists in forensic medicine and forensic psychiatry, who are trained by relevant departments of medical universities) in Ukraine have been trained through the retraining of individuals who hold either natural sciences or legal degrees. As a result of such retraining, these individuals obtained so-called admission – a qualification certificate granting the right to conduct specific types of forensic examinations.

For the independent training of newly hired employees who are not yet authorized to perform forensic examinations, an individual plan is drawn up and approved by the head of the forensic institution according to the expert training program of the respective agency. A mentor, selected from the most experienced employees, is assigned to a trainee who lacks forensic qualifications. The mentor provides methodological assistance in mastering theoretical courses, acquiring practical skills with instruments and equipment, monitors the implementation of the individual training plan, and involves the trainee in forensic examinations and studies.

Unfortunately, physicists, chemists, biologists, engineers, and other specialists with natural science or technical backgrounds, who are recruited to forensic institutions, often lack even the basic knowledge of substantive and procedural law, criminalistics, and forensic science theory. Typically, they are experts in very narrow fields, and the knowledge, gained during their university studies, is used only partially – about 20–30%. Internships and short courses, designed to teach them the basics of procedural law and criminalistics, fail to provide the necessary depth. Legal knowledge and general legal culture, which are crucial for forensic experts in their daily work, are usually acquired only after several years of practical experience, which leads to numerous expert errors and omissions.

Lawyers who still undergo retraining as forensic experts face even greater difficulties since they lack the necessary technical and scientific foundation to work with increasingly complex expert equipment.

Thus, in Ukraine, professional forensic expert activity may be carried out by:

a) employees of state specialized forensic institutions who have been trained at specialized state institutions;

b) private forensic experts who are not employees of such institutions but have completed training (internship) at specialized institutions under the Ministry of Justice of Ukraine and have obtained the qualification of a forensic expert;

c) other specialists (experts) from relevant fields of knowledge under the procedures and conditions, defined by the Law.

It is important to note that the training programs for candidates applying for positions in the system of research institutions of forensic examinations under the Ministry of Justice of Ukraine, the expert services of the Ministry of Internal Affairs, the Ministry of Defence, the Security Service of Ukraine, and the State Border Guard Service of Ukraine are defined by internal departmental documents and may differ, considering the specificities of the future professional activity depending on the agency.

Within the framework of this study, for illustration purposes, we will examine two training programs for candidates applying for the position of forensic expert in institutions under the Ministry of Justice of Ukraine, using the example of expert specialties 4.1 "Examination of Human and Animal Traces" and 1.1 "Examination of Handwriting and Signatures" (**Tables 2.3–2.5**) [21].

Firstly, it should be noted that the training of specialists who intend to obtain the qualification of a forensic expert and work in state specialised institutions or not to be an employee of these institutions is divided into two stages. The first stage is carried out under a training programme on theoretical, organisational and procedural issues of forensic examination. So far, the National Scientific Centre 'Bokarius Institute of Forensic Expertise named after Hon. Prof. M.S. Bokarius' has a licence to conduct educational activities in the field of internship under this programme [21].

Table 2.3 Typical thematic plan

No.	Topic name	Total teaching hours	Lecture sessions	Practical sessions
1	**2**	**3**	**4**	**5**
1	Theoretical foundations of forensic examination and the history of its development. The concept of forensic examination, subject, object and tasks of forensic examination. The role of forensic examination as a means of proof	4	4	–
2	Forensic activity. Regulatory and legal acts regulating forensic activity in Ukraine. Subjects of forensic activity. Standardization of forensic activity according to international standards	8	8	–

● **Continuation of Table 2.3**

1	2	3	4	5
3	Forensic examination methods. Expert methods. Stages of expert research	4	4	–
4	Forensic expert, his/her rights and obligations. Legal responsibility of a forensic expert. Expert and specialist (procedural aspect)	8	8	–
5	Forensic expertise as a form of using specialized knowledge. Classification of forensic expertise	4	4	–
6	The procedure for appointing a forensic examination in various types of legal proceedings. Organization of forensic examination	8	8	–
7	Expert opinion (structure, content, design)	4	4	–
Total number of hours		40	40	–

The second stage of training takes place directly at the expert institution in accordance with the training programs for the relevant expert specialties.

● **Table 2.4** Typical thematic plan for training in expert specialty 4.1 "Research of human and animal traces"

No.	Topic name	Total teaching hours	Lecture sessions	Practical sessions
1	2	3	4	5
1	Subject and system of forensic trace examinations. Forensic science about traces. Identification and diagnostic studies in trace examination	6	6	–
2	Identification and diagnostic studies in trace examination	6	6	–
3	Detection, fixation and removal of traces at the scene of the crime	7	7	–
4	General methodology of forensic trace research	7	7	–
5	Examination of human footprints and shoe prints	48	7	41
6	Examination of traces of teeth, lips, auricles and skin of a person's head	49	7	42
7	Examination of human properties (motor skills) by knots and loops, connected by them	49	7	42
8	Examination of the mechanism of soil layer formation on clothing and footwear	49	7	42

● **Continuation of Table 2.4**

1	2	3	4	5
9	Glove trace examination	49	7	42
10	Animal footprint examination	49	7	42
11	Preparation of draft expert opinions	20	–	20
12	Reviewing draft expert opinions	6	–	6
Total hours		345	68	277

● **Table 2.5** Typical thematic plan for the preparation of the expert specialty "Study of handwriting and signatures"

No.	Topic name	Total teaching hours	Lecture sessions	Practical sessions
1	Theoretical and methodological principles of forensic handwriting examination	10	1	9
2	Theoretical and methodological principles of forensic handwriting examination	1	1	9
3	Procedural and methodological provisions for the appointment and conduct of forensic handwriting examination. Registration of research results	5	5	–
4	The concept of handwriting examination methodology and general principles of its construction	15	3	12
5	Systematization of handwriting and signature features	20	2	18
6	Identification study of handwritten texts, executed under usual conditions	20	3	17
7	Study of handwritten texts, executed under the influence of any confounding factors	67	15	52
8	Research of signatures made under usual conditions	40	5	35
9	Research of signatures, made under the influence of natural distracting factors	35	5	30
10	Research of signatures, made under the influence of artificial distracting factors	30	5	25
11	Complex research in solving forensic handwriting problems	10	2	8
12	Preparation of draft conclusions	20	–	20
13	Review of conclusions (draft conclusions)	6	–	6
Total number of hours		288	47	241

For further comparison of expert training systems, the specified hours will be converted into the number of credits, required to obtain an educational qualification of a certain degree in the relevant specialty. ECTS, or the European Credit Transfer and Accumulation System, is a pan-European system for credit transfer and accumulation.

Thus, the training program for forensic experts specializing in 1.1 "Handwriting and Signature Analysis" amounts to 11 ECTS credits, excluding prior higher academic education.

The training program for forensic experts specializing in 4.1 «Human and Animal Trace Analysis» amounts to 13 ECTS credits, excluding prior higher academic education.

Undoubtedly, the quality of forensic expert training through individual and group internships and short-term courses cannot compare to systematic education in higher education institutions.

Forensic expertise allows for specialization. This raises the question of what educational and knowledge requirements should be imposed on future forensic experts in the current stage of scientific development, given the complexity of the tasks, assigned to them.

In Ukraine, the issue of the necessity of specialized forensic expert training remains unresolved. One approach to forensic expert training involves a standardized approach to general professional disciplines while defining specialized disciplines based on types of forensic expertise. Proponents of this approach propose training forensic experts in higher education institutions under the Ministry of Internal Affairs of Ukraine through a six-year educational program. Graduates receive a diploma in «Forensic Expertise» and are authorized to conduct traditional forensic examinations, including trace analysis, fingerprint analysis, ballistics, cold weapons analysis, portrait expertise, handwriting analysis, and forensic technical document examination. The training of experts in forensic engineering and technical expertise could be conducted in technical universities with appropriate equipment, as well as in law faculties in the format of a second legal education.

Despite significant advancements in the development of educational programs, the key issue remains the insufficient integration of practice into the educational process. For instance, only a limited number of students have access to modern laboratory equipment, and internships in forensic institutions are not always mandatory and, under martial law conditions, not always feasible. The main reasons for the lack of practical training in forensic education include:

– overemphasis on theory: educational programs often focus on theoretical aspects while neglecting practical application;

– lack of interaction with employers: weak connections between educational institutions and stakeholders lead to educational programs that do not align with real labor market needs;

– cultural and intellectual barriers: in Ukraine, the stereotype that a diploma is the main criterion of success remains widespread, complicating the implementation of alternative learning and assessment formats.

However, in recent years, there has been a positive trend, including the introduction of digital forensics courses to combat cyber threats, the use of 3D modeling for crime scene reconstruction, and the training of forensic genomics experts to work with biological evidence.

In our view, forensic expert training should be based on a combination of several key approaches.

Firstly, an interdisciplinary approach. Forensic expertise requires the integration of knowledge from various fields, including law, criminalistics, natural sciences, computer technology, and psychology. For example, a digital forensics expert must understand the legal foundations of evidence collection, methods of retrieving and analyzing digital data, and the ethical aspects of the work. The educational program should prepare graduates to perform tasks in various fields, including legal, forensic, technical-criminalistic, and consulting areas. Implementation of this approach can include:

– development of joint projects, where students participate in real investigations under the guidance of specialists from different disciplines;

– creation of interdisciplinary study groups, in which students from different specialties (lawyers, IT specialists, biologists, etc.) collaborate on forensic cases, simulating real expert group work;

– use of digital platforms to access databases, simulate forensic processes, and enable interdisciplinary student interaction.

Secondly, a competency-based approach. Educational programs should focus on developing professional competencies, including:

– analytical thinking;

– problem-solving skills;

– teamwork abilities;

– oral and written communication skills.

Third, an innovative approach. In today's environment, forensic training is impossible without the use of cutting-edge technologies, such as artificial intelligence, blockchain to ensure the integrity of evidence, as well as modern laboratory tools for DNA analysis, toxicology and digital data.

In addition, it is important to undergo appropriate training-internship with an experienced mentor to gain access to the accumulated experience in the field of forensic examination.

We also emphasize that active participation in professional organizations on platforms for sharing research results, collaborating on complex cases and solving problems and ethical issues in the forensic examination community, and obtaining training opportunities are important for forensic experts to stay abreast of the latest developments, methods and best practices in their field.

The most suitable for the expert system of Ukraine, according to many experts, is the European model of education. It should be noted that in European countries reforms were carried out simultaneously in all spheres of life, including education. Only successful reforms by a country became the basis for becoming a candidate for accession to the European Community. For the training of experts, both general and special criteria were developed, which were reflected in documents on education [22–28].

The developed criteria embodied all the best taken from the activities of various European reformer countries in the field of forensic expertise. Educational reforms in European countries, in turn, began long before the adoption of the Bologna Agreement, ratified on June 19, 1999 in the city of Bologna (Italy), and signed by 29 ministers of education. The document was later called the "Bologna Declaration". With this act, the participating countries agreed on the general

requirements, criteria and standards of the national higher education system, creating the European Educational and Scientific Space since 2010.

Within the framework of this study, for clarity, we will examine the forensic expert training program using the example of the Swiss University L'Université de Lausanne (**Fig. 2.1–2.3**) [28].

The first degree – Bachelor of Criminology/Forensic Science, is the first step in basic scientific training, which allows you to acquire a methodological, scientific and forensic way of thinking.

The bachelor's degree is valued at 180 ECTS credits and usually lasts 6 semesters. The forensic science education program is a comprehensive, interdisciplinary scientific training program that, in addition to forensic science itself, includes subjects from the natural sciences, such as physics, biology, mathematics and especially chemistry, as well as a significant component from the humanities (criminal law, criminology), medicine (forensic medicine) and engineering (computer science, visualization). The proportion of laboratory work is very high in relation to courses and seminars.

To obtain the degree of Bachelor of Forensic Science and Bachelor of Science (BSc) in Forensic Science, it is necessary to be admitted to the University of Lausanne on the basis of their qualifications, in accordance with art. 81 of the RLUL; on the basis of a dossier, in accordance with art. 82b and 82c of the ZZNU and Directive 3.16 of the Executive Board; after a preliminary examination in accordance with art. 82 and 82a of the ZZRP, as well as the Regulation governing the preliminary examination for admission to work in the ESCB, and Directive 3.16 of the Executive Board.

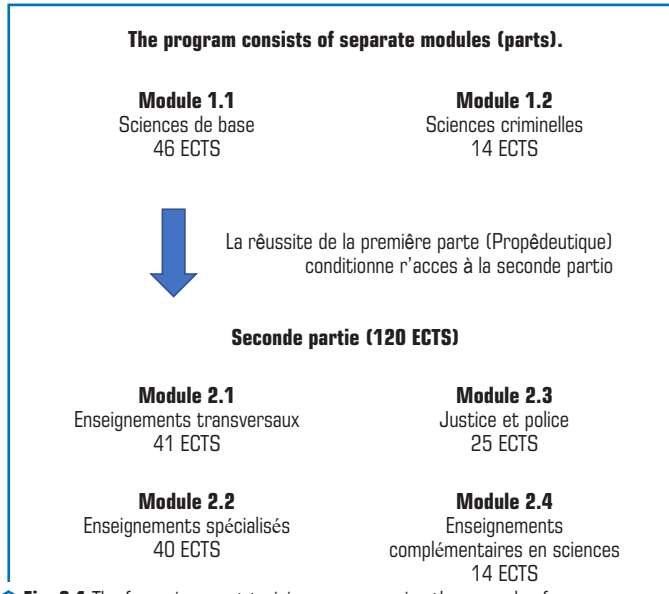

Fig. 2.1 The forensic expert training program using the example of the Swiss University L'Université de Lausanne

The university bachelor's degree curriculum establishes a list of subjects that must be passed in the 1st series of examinations to obtain 60 ECTS credits (module 1). Students must pass the 1st series of examinations for the bachelor's degree during the summer and/or autumn session immediately following the relevant academic year. Failure to meet this requirement will be considered an unsatisfactory grade, except in cases of authorized academic leave or force majeure. The 1st year of study aims to lay the theoretical foundations in chemistry, basic sciences and forensics.

Curriculum
MODULE 1 (60 ECTS) Bachelor's plan

Module 1.1: Fundamental Sciences (46 ECTS)	**Module 1.2: Forensic Science (14 ECTS)**
Mathematics I	General Forensic Science: Typology of Traces
Mathematics II	General Forensic Science: Methodology
Algorithms and Computational Thinking	Introduction to Law/Methodology
Python Programming	Introduction to Criminology
Computation and Networks	
Experimental Physics I	
Experimental Physics II	
Advanced General Chemistry	
Organic Chemistry	
Chemistry TP	

Fig. 2.2 Module 1 of the forensic expert training program using the example of the Swiss University L'Université de Lausanne

In the second module, the program becomes more specialized and focuses more on forensics.

The curriculum lists the subjects, included in module 3. The exams of the third series of the Bachelor of Laws lead to 63 ECTS credits.

Each discipline is considered completed if the grade received is at least 4 or if the assessment is marked as "pass". Upon meeting this requirement, the corresponding ECTS credits for that discipline are awarded.

The curriculum also requires students to engage in independent research on a given topic.

To obtain a Bachelor's degree in forensic science/criminalistics, students must complete all modules within the maximum duration of study. In cases of unsatisfactory academic performance, ECTS credits are granted only for completed modules. A student who fails to complete the university's undergraduate program in forensic science is expelled from the program and is no longer eligible for re-enrollment in this course.

Upon meeting all academic requirements, the student is awarded a degree titled: Baccalauréat universitaire ès Sciences en science forensique/Bachelor of Science (BSc) in Forensic Science/ Bachelor of Science (BSc) in Criminalistics.

The Master of Science in Forensic Science is a graduate program comprising 120 ECTS credits with an expected duration of four semesters. The primary objective of this master's program is to enable students to develop, deepen, and expand the knowledge, acquired during their undergraduate studies in forensic science.

MODULE 2 (120 ECTS credits)

Module 2.1: Interdisciplinary Teaching (41 ECTS credits)	**Module 2.2: Specialized Teaching (40 ECTS credits)**
Microscopy	Papiral Traces
Forensic Tactics	Biological Traces
Introduction to Digital Forensics	Object Traces
Introduction to Interpretation of Scientific Evidence	Detection of Traces of People and Objects
Crime Scene Investigation Techniques	Practical Digital Forensics
Forensic Practice	Exploitation of Digital Traces
Independent Work	Inorganic Microtraces
	Fire Investigation Methods
	Drugs
	Firearms
	Technical Document Examination
Module 2.3: Justice and Police (25 ECTS credits)	**Module 2.4: Additional Science Courses (14 ECTS credits)**
Forensic Investigation	Probability and Statistics
Criminal Law	Biochemistry I
Special Criminal Law	Structural Analysis
Court Organization and Procedure	Analytical Separation Methods
Forensic Medicine	
Introduction to Criminological Methods	

Fig. 2.3 Module 2 of the forensic expert training program using the example of the Swiss University L'Université de Lausanne

This master's program offers three distinct specializations:

– identification: a transdisciplinary curriculum covering key areas of forensic identification, including fingerprint analysis, DNA analysis, biometrics, toolmark examination, firearm examination, and handwriting/signature analysis, with a particular focus on probabilistic methods of interpretation.

– forensic chemistry: this specialization aims to study analytical chemistry methods. The program consists of a theoretical component, complemented by practical laboratory work utilizing analytical chemistry techniques and their forensic applications.

– digital investigation and identification.

Students must choose their specialization upon enrollment in the program.

Thus, the total number of earned credits amounts to 300 ECTS. For comparison, in Ukraine, the equivalent figures are 13 ECTS and 11 ECTS.

In our opinion, there are significant prospects for Ukraine in this field. To align the Ukrainian system with international standards, the following measures should be implemented:

– increase practical training: establish forensic training centers and provide access to modern equipment;

– enhance international cooperation: conclude agreements with foreign universities to facilitate knowledge exchange;

– implement innovations: develop courses integrating artificial intelligence and digital technologies;

– improve ethical training: emphasize accountability for forensic examination results.

By embracing innovation while maintaining a commitment to scientific rigor and ethical principles, forensic experts can harness the power of modern technologies to enhance the accuracy, efficiency, and reliability of their work, ultimately reinforcing the credibility of forensic science.

CONCLUSION

The harmonization of forensic expert training with modern development trends is a strategically important task for ensuring the efficiency of the justice system. An analysis of the experiences of Ukraine and eight leading countries (the USA, Germany, the United Kingdom, France, Canada, Switzerland, Australia, and Poland) highlights several key aspects requiring special attention. Globalization, technological progress, and the intensification of integration processes necessitate a revision of traditional approaches to expert training, prompting the development of new educational models, adapted to contemporary challenges.

An analysis of international experience shows that the most effective forensic expert training systems are based on an interdisciplinary approach that combines theoretical knowledge, practical training, and the use of innovative technologies.

Integrating practical experience into the educational process through the creation of training laboratories, an increased number of internships in real forensic institutions, and student involvement in real casework-will contribute to the development of professional skills and enhance graduates' competitiveness in the labor market.

Additionally, the implementation of innovative technologies, including artificial intelligence, machine learning, blockchain, 3D modeling, and modern laboratory methods, will ensure high accuracy and objectivity in forensic examinations.

International cooperation must function on an ongoing basis. The conclusion of agreements between Ukrainian and foreign universities, the organization of academic exchange programs, and joint research initiatives will facilitate the integration of Ukraine's forensic expert training system into the global community.

A significant aspect is the adaptation of educational programs to international standards, which involves the introduction of mandatory modules on forensic informatics, cybersecurity, and forensic genomics into the curriculum. This harmonization will enhance the competitiveness of Ukrainian experts on a global scale, opening new opportunities for professional growth and international collaboration.

Forensic expert training should encompass not only knowledge of specialized methodologies and procedures but also the development of critical thinking, analytical skills, and the ability to work with large volumes of information. Modern forensic research increasingly relies on big data analysis, requiring experts to effectively use analytical tools, assess the reliability of information, and formulate well-reasoned conclusions.

A particularly important issue is professional ethics and the independence of forensic experts. The development of an ethical culture, high standards of professional ethics, and responsibility for forensic conclusions are crucial for strengthening public trust in the justice system.

Moreover, interdisciplinarity plays a key role. Expanding educational programs by integrating knowledge from related fields (such as psychology, information technology, and natural sciences) will enable specialists to work effectively in response to modern challenges.

Ukraine has already made some progress in this area, particularly in developing educational programs in digital forensics, forensic genomics, and the application of advanced technologies in evidence analysis. However, further modernization is needed, which includes incorporating international experience, expanding funding, and creating conditions for graduates to integrate into the global labor market.

Additionally, the possibility of implementing a dual-degree system for forensic experts should be considered, allowing them to receive education simultaneously at Ukrainian and European institutions. This approach will enhance expert qualifications and support their professional development in an international context.

Thus, the harmonization of forensic expert training with modern development trends is a multifaceted process that requires the synergy of efforts from the state, academic institutions, educational establishments, and international partners. Only through a systematic approach can Ukraine prepare specialists who meet the highest standards and effectively contribute to the justice system.

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