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CHAPTER 2.
USE OF SPECIAL KNOWLEDGE OF SPECIALISTS IN THE FIELD OF FORENSIC BALLISTICS IN THE PROCESS OF CONDUCTING INVESTIGATIVE ACTIONS AND EXPERT RESEARCH ON CRIMINAL OFFENCES AGAINST THE FOUNDATIONS OF NATIONAL SECURITY

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Abstract. In the scientific materials, an analysis of scientific publications on the use of special knowledge of specialists in the field of forensic ballistics in the process of conducting investigative actions and expert research on criminal offences against the foundations of national security is carried out by the authors. The authors in their materials determine that when conducting a crime scene inspection in criminal offences against the foundations of national security, the investigator can independently formulate probable tactical conclusions that are optimal for a given investigative situation. Recreating a model of the crime event is based on a complex analysis of the information received, on the basis of which the investigator can make one of the tactical decisions on conducting investigative (detective) actions that are typical for the circumstances of the pre-trial investigation.

The most frequently found traces of the use of firearms in criminal offences against the foundations of national security include projectiles (bullets, buckshot, shot); shell casings; wads; traces of injury to the human or animal body; holes in various objects, detachments; traces of projectile ricochet; unburned dust particles; traces of soot; traces of thermal effects; muzzle prints on an obstacle. It is very important to find as many traces of the use of weapons at the scene as possible, as they will allow to draw important conclusions both about the weapon used and about the mechanism of committing a criminal offence against the foundations of national security.

The authors come to the conclusion that the use of special knowledge of specialists in the field of forensic ballistics in the process of conducting investigative actions and expert research on criminal offences against the foundations of national security is particularly relevant today, using the modern possibilities of knowledge of technical forensic methods which allow experts (specialists) to apply the methods developed by specialists for modelling the trajectory of a bullet flight by damage in an obstacle using a laser.

Key words: security, state, crime, nation, forensic expert, crime scene, forensics, review, event.

Introduction. The relevance of the topic is due to the fact that in the investigation of criminal offences against the foundations of national security, such as actions aimed at violent change or overthrow of the constitutional order or the seizure of state power, encroachment on the territorial integrity and inviolability of Ukraine, sabotage, espionage, such investigative action as inspection of the scene of an incident presents unique challenges and requires special procedures and professional knowledge and skills of both the investigator and specialists (explosive experts, trace evidence experts, ballisticians and forensic experts) involved in its conduct.

It is worth noting that according to the official data of the Office of the Prosecutor General of Ukraine, the number of crimes against the foundations of national security in January-December 2023 was 6269, and in the period from January to December 2022, 17422 crimes were registered, as shown in Figs. 1 and Figs. 2).

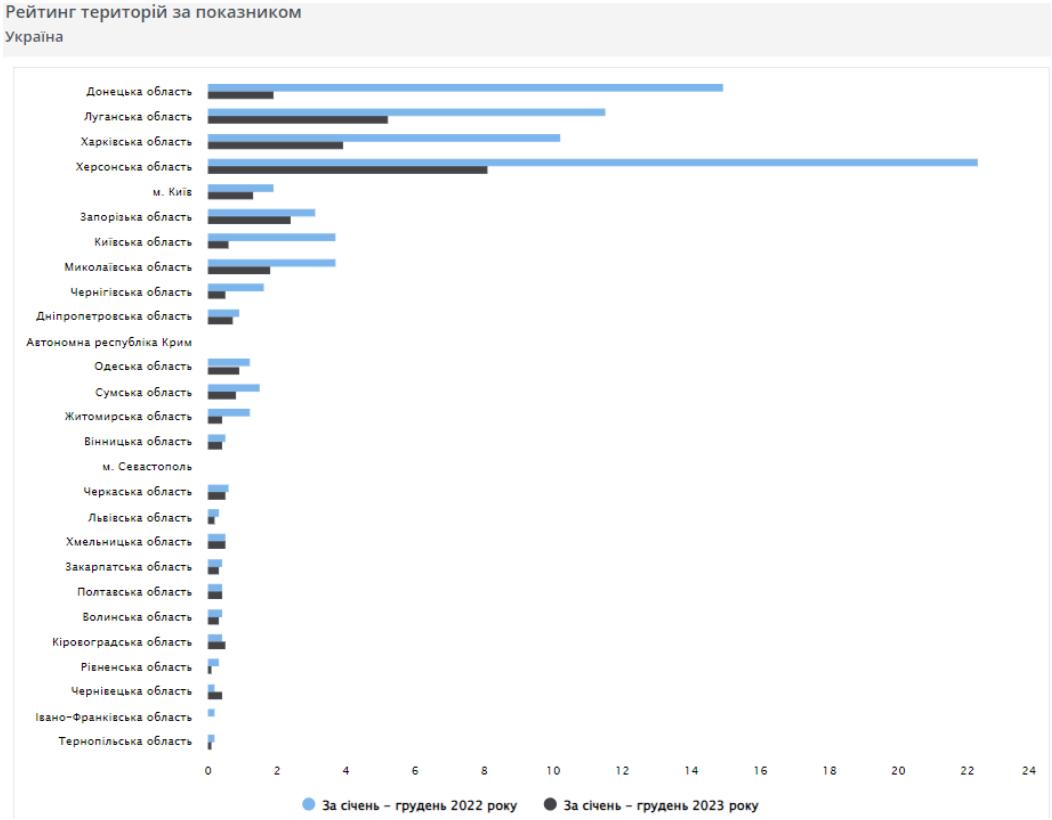

Fig. 1 Rating of Ukrainian regions by crimes against the foundations of national security in 2022 and 2023.

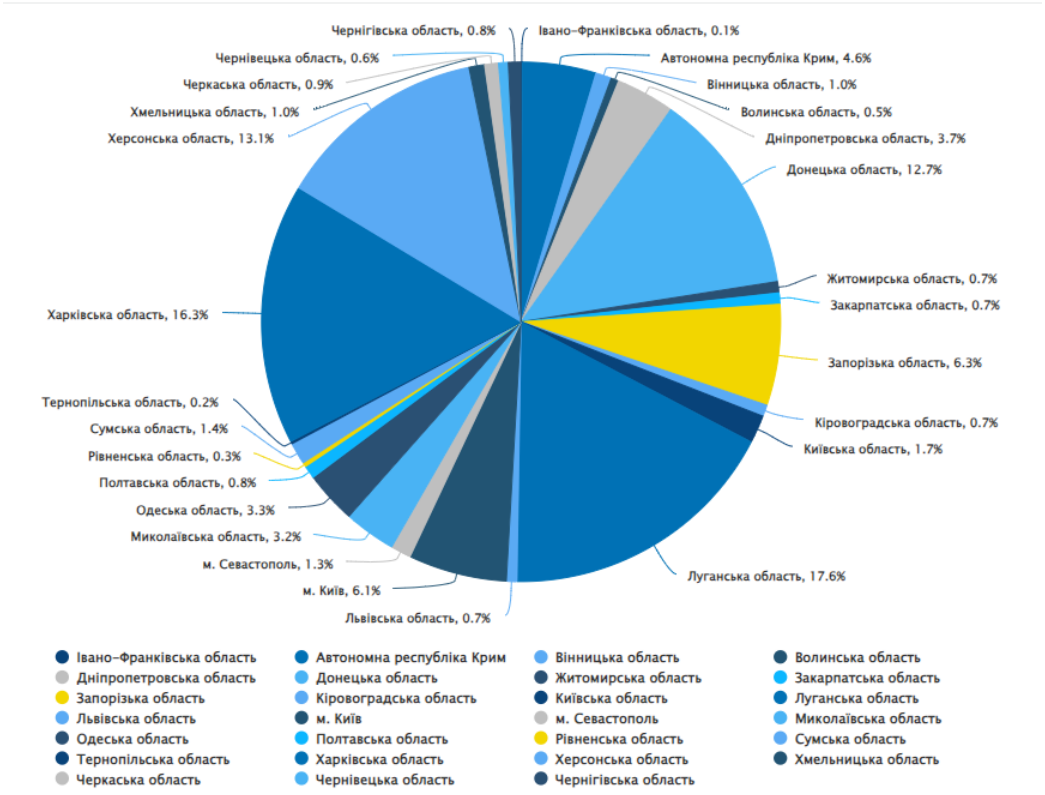

Fig. 2 Indicators of crimes against the foundations of national security by regions of Ukraine in 2023

Analysis of scientific publications.

In international forensics, the examination of an incident scene is studied from the point of view of scientific investigation of traces: collection of physical evidence, forensic photography, fingerprinting, bloodstain analysis, ballistic, trace and toxicological examination, vehicle examination, forensic examination of writing; technical and forensic examination of documents; identification of a person by appearance; criminal registration. It is worth noting that the most commonly used methods of investigation are fingerprints and shoe prints at the crime scene.

Analysis of scientific articles allows us to determine, the paper scientific Kapil Kumar Nagwanshi, Amit Kumar Gupta, Tilottama Goswami, Sunil Pathak and Maleika Heenaye-Mamode Khan, proposes one of the low-cost hardware to scan the biometric human footprints that utilise image pre-processing and enhancement capabilities for obtaining the features. The algorithm enhances the footprint matching performance by selecting the three sets of local invariant feature detectors - histogram of gradients, maximally stable external regions, and speed up robust features; local binary pattern as texture descriptor, corner point detector, and PCA. Furthermore, descriptive statistics are generated from all the above mentioned footprint features and concatenated to create the final feature vector. The proposed footprint biometric identification will correctly identify or classify the person by training the system with patterns of the interested subjects using an artificial neural network model specially designed for this task. The proposed method gives the classification accuracy at a very encouraging level of 99.55% *(Kapil Kumar Nagwanshi, Amit Kumar Gupta, Tilottama Goswami, Sunil Pathak, Maleika Heenaye-Mamode Khan, 2023).*

In the scientific publication of the authors Brajesh Kumar Singh, Ravinder Kumar and R. Rama Kishore, it is determined that biometric identification is an emerging field for personal authentication and has a large number of applications in the field of time attendance system and forensic domain. A variety of biometric traits are available, but among them, hand-based biometrics are more popular because of their ease of use and better performance. A lot of literature is available on fingerprint identification but it is observed that fingerprints are always not a reliable source of information to be captured from the crime scene to identify suspects. Therefore, it is required to use some other hand-based biological trait such as finger knuckle print (back side of finger joint skin pattern) in order to identify the suspect. This paper proposed a finger knuckle image-based person identification. The performance of the proposed biometric system is compared with the well-established fingerprint-based authentication system. The experiments were performed on the benchmark dataset like PolyU finger knuckle print dataset and FVC2002 fingerprint dataset. The experimental results show that the performance of the proposed algorithm leads over many fingerprint-based identification systems. The proposed algorithm can also be used to design finger

knuckle image-based biometric systems instead of fingerprint-based biometric systems *(Brajesh Kumar Singh, Ravinder Kumar, R. Rama Kishore, 2021).*

In the scientific publication of the author Xiangyang Wang it is in the practical application of traditional fingerprint identification algorithm, the error of fingerprint detail feature extraction is high, and the effect of edge recognition is poor. Therefore, the application research of fingerprint automatic identification algorithm in criminal investigation is proposed. Firstly, the collected fingerprint image is preprocessed to obtain the size of fingerprint effective area and fingerprint image grey level. Based on Gabor filter, the balanced and normalised fingerprint image is segmented and enhanced by filtering. Finally, feature extraction, classification and detail matching are carried out for the enhanced fingerprint. The experimental results show that the error value of the algorithm is relatively stable, the edge recognition effect is good, and the effective information loss rate is low. It has a good effect in the practical application of criminal investigation *(Xiangyang Wang, 2022).*

In the scientific publication of the authors John Songa, Theodore V. Vorburgera, Wei Chua, James Yenb, Johannes A. Soonsa, Daniel B. Otta, Nien Fan Zhang it is determined that Tool marks are permanent changes in the topography of a surface created by forced contact with a harder object (the tool). When bullets and cartridge cases are fired or ejected from a firearm, the parts of the firearm that make forcible contact with them create characteristic tool marks called "ballistic signatures" *(John Songa, Theodore V. Vorburgera, Wei Chua, James Yenb, Johannes A. Soonsa, Daniel B. Otta, Nien Fan Zhang, 2018).* By examining these ballistic signatures side-by-side in a comparison microscope, firearm examiners can determine whether a pair of bullets or cartridge cases was fired or ejected from the same firearm. Firearm examiners can then connect a recovered firearm or other firearm evidence to criminal acts. Estimating error rates for firearm evidence identification is a fundamental challenge in forensic science.

This paper describes the recently developed congruent matching cells (CMC) method for image comparisons, its application to firearm evidence identification, and its usage and initial tests for error rate estimation. The CMC method divides compared topography images into correlation cells. Four identification parameters are defined for quantifying both the topography similarity of the correlated cell pairs and the pattern congruency of the registered cell locations. A declared match requires a significant number of CMCs, i.e., cell pairs that meet all similarity and congruency requirements. Initial testing on breech face impressions of a set of 40 cartridge cases fired with consecutively manufactured pistol slides showed wide separation between the distributions of CMC numbers observed for known matching and known non-matching image pairs. Another test on 95 cartridge cases from a different set of slides manufactured by the same process also yielded widely separated distributions. The test results were used to develop two statistical models for the probability

mass function of CMC correlation scores. The models were applied to develop a framework for estimating cumulative false positive and false negative error rates and individual error rates of declared matches and non-matches for this population of breech face impressions. The prospect for applying the models to large populations and realistic case work is also discussed. The CMC method can provide a statistical foundation for estimating error rates in firearm evidence identifications, thus emulating methods used for forensic identification of DNA evidence *(John Songa, Theodore V. Vorburgera, Wei Chua, James Yenb, Johannes A. Soonsa, Daniel B. Otta, Nien Fan Zhang, 2018).*

It is advisable to emphasise the scientific publications on the above-mentioned issues of forensic firearms research by domestic Ukrainian scientists and practitioners. Thus, in the scientific article by Melnyk R.V., Goldinsky I.A., Gamera V.A., a comprehensive consideration of the forensic examination of firearms was presented, the authors came to the conclusion that the use of firearms in the commission of crimes leads to numerous traces at the scene. Traces of weapons are diverse and depend on many factors: the model of the weapon, the ammunition used, the conditions of the crime, and the actions taken by the perpetrator to conceal the traces of the crime. It was found out that traces of weapons are, first of all, traces-objects: abandoned weapons, ammunition, various things (chamber, wipe, holster, packaging material in which the weapon was stored (fabric, paper, wood)), as well as misfired cartridges, shell, shot, wads, gaskets, unburned dust, traces of soot. These are also traces of interaction of weapons and ammunition with objects in the environment: holes, dents, broken objects (glass, ceramic), and finally, traces on the human body, tears, soot on fabrics (wipe strip), rooted dust particles, burns, etc. The largest number of traces of weapons remains on shell casings, projectiles (bullet, shot), obstacles (objects, human body), the body of the shooter and the victim (on the hands, face, clothes). Therefore, when inspecting the scene, these sources of information deserve special attention, and it is necessary to examine them and investigate them with the involvement of a specialist. The type of traces and their location will help to resolve many of the issues faced by the investigator. In addition, their fixation will ensure the successful conduct of forensic ballistics and other forensic examinations. In order to investigate a crime committed with the use of firearms, it is necessary to have a clear understanding of the mechanism of trace formation, means of fixation and examination. Forensic research can be aimed at examining the weapon itself, as well as at examining ammunition, including fired bullets and shell casings, and at examining the traces of the spent bullets and shell casings *(Melnyk R.V., Goldinsky I.A., Gamera V.A., 2016).*

In the scientific publication of forensic experts Tsyganov S.M., Trotsenko A.M. (2019) titled: "Specific conditions of forensic investigation of homemade firearms in Ukraine" highlights the main specific conditions of forensic investigation of homemade firearms in Ukraine: legislative failure to define the concept, obsolescence of current forensic ballistics techniques, free access to the technique

of manufacturing such weapons in artisanal conditions. An analysis is made of the positions and views of domestic forensic scientists on the interpretation of the concept of "homemade firearms". The authors conclude that there is no single standardised definition of the concept of "homemade firearms"; this concept is classified as an atypical, non-standard weapon, which complicates the forensic ballistic identification of its samples in the course of examination. The methodological obsolescence of the accepted practices of forensic ballistic examination of this group of firearms. Widespread popularisation and public access to specific techniques and technological procedures for the homemade manufacture of such weapons in artisanal conditions. In addition, at the methodological level, a number of issues of classification studies of samples of modern atypical weapons and methods of their manufacture have not yet been resolved. The need to adopt the Law of Ukraine "On Weapons" in the near future and to radically update the existing methods of forensic ballistics research *(Tsyganov S.M., Trotsenko A.M., 2019).*

In the scientific publication Bondar V.S. is devoted to the research of theoretical and practical issues of optimization of information and analytical support for the detection and investigation of crimes committed with the use of firearms. The article presents the results of the analysis of the positive experience of implementing a national ballistic image comparison project conducted by the National Institute of Standards and Technology (NIST). Possibilities of forensic accounting during investigation of crimes of this category are identified, which, in particular, will help the investigator to properly analyze and evaluate:

the work of a forensic specialist during the conduct of individual investigative (search) actions (inspection of the scene, search, etc.);

the complexity of the removal of all information traces and other material evidence;

results of the rapid analysis of the traces removed and other material evidence, which is carried out by a specialist during the conduct of investigative (search) actions;

the completeness of the assignment and the results of the forensic and special types of expert studies, the correct interpretation of the investigators' findings and the effectiveness of their use in the further investigation of criminal proceedings;

objectivity of the conducted checks of all investigated material evidence in criminal records, use of the information obtained to identify the offender.

The main types of information classified by logical and structural analysis, which contains the signs of their perpetration by the same persons, facilitates the classification of specific series of criminal offenses to one or another of their classification groups, in particular: a) forensic; b) medical and biological; c) ballistic; d) trasological; e) biological; (f) odorant; g) technical (design and technological); e) other forensic science *(Bondar V.S., 2019)*.

The main content of the work.

The detection and investigation of criminal offenses committed with the use of firearms against the foundations of national security is directly dependent on a tactically correctly organized and conducted examination of the scene of the event. With regard to criminal proceedings of this category, the specific objects of inspection are traces of firearms use, primarily fired bullets, shell casings, shot, soot, holes and damage in various obstacles, including lesions on the human body and clothing, etc. The general tasks of inspecting the scene of an incident with traces of firearms use will always be: identifying, fixing and removing the weapon from which the shots were fired, ammunition, shell casings, bullets, and shot marks; recording in detail the location of the traces and objects found; recording the situation and its characteristic features that may be related to the use of weapons.

In all cases, the investigator and all participants of the investigative (detective) action must follow the general rules that are acceptable for the inspection of any scene. However, it is worth noting that during the inspection of the material situation at the scene of the incident, which contains traces of the use of firearms, the investigator should not be limited to the mechanical collection of various objects, without taking into account the significance of a particular trace or object for the investigation of a criminal offence. Therefore, the investigator's work at the scene is aimed not only at identifying and fixing traces and material evidence, but also at recreating in his or her mind the course of the event and the actions of the persons involved. Modelling such a situation directs the investigator to work in a certain direction. The reliability of the investigator's model of the crime depends on the investigator's special knowledge of ballistics, forensic medicine and the general provisions of forensic technology. It is important to know the techniques and methods of detecting and fixing ballistic objects, as well as the investigator's knowledge of the mechanism of gunshot marks. Sometimes it is believed that the investigator does not need knowledge of forensic ballistics when examining the scene of an incident because the investigative team should include a relevant forensic specialist who will assist him/her in identifying, fixing and qualified seizure of gunshot marks and other ballistic objects. Such approaches to conducting an investigative (detective) action are wrong, because it is the investigator who is responsible for the proper organisation of the work of the investigative team and the completeness and objectivity of the examination of the scene. Therefore, already during the inspection, i.e. before a special forensic examination of the detected ballistic objects, the investigator can independently and with the assistance of a specialist resolve a number of tactically important issues: determine the type of weapon, direction of the shot, location of the person who shot, etc. Based on the location of shell casings and wades at the scene, it is possible to put forward a version of where the shot was fired by the smell from the barrel of the found firearm,

to make an assumption about the age of the shot, and to determine the type of weapon used by the shape and size of bullets or shell casings.

When examining a corpse at the scene of an assault on the life of a state or public figure with signs of gunshot wounds, the investigator should pay attention to such features as damage to clothing, the presence of bullets, pellets, secondary shells, etc. in clothing items, the number of injuries and their location, shape, size, correspondence of the injuries to the injuries on the victim's clothing, the presence of powder soot, powder residues and the area they occupy on the body or on the fabric of the clothing, the presence of a muzzle mark of the weapon and fabric tears in the area of the entrance hole, the nature of the injury (through, blind, tangential) and its features, the presence of blood traces, their features, etc.

The investigator should be aware that in cases of homicide with the use of firearms, the persons who were present at the crime scene can be identified by traces of gunshot residue on their bodies and clothing. In addition, the topography and intensity of such traces in many cases makes it possible to identify the person who held the weapon at the time of the shot and the persons who were in the immediate vicinity of the weapon at the time of the shot. Gunshot residue is deposited both on the affected obstacle and on other carrier objects, in particular on the inner surface of the fired cartridge case and the barrel channel, as well as on the surfaces of objects that have come into contact with the weapon. Such objects can be the inside of clothing pockets, suitcases, bags in which the weapon was carried after the shot was fired. The organic part of such traces is gunpowder, which is based on nitrocellulose, as well as its combustion products, in particular nitrogen oxides. The place of the crime, the relative position of the perpetrator and the victim, the direction and distance of the shot, the type of gunpowder used and the type of weapon can be established by unburned gunpowder particles found at the scene. In such cases, it is important to know not only why and for what reason such traces remain at the scene, but also the reasons why they may disappear.

Thus, during the inspection of the scene, the investigator can independently formulate probable tactical conclusions that are optimal for a given investigative situation. Recreating a model of the crime event is based on a comprehensive analysis of the information received, on the basis of which the investigator can make one of the tactical decisions on conducting investigative (detective) actions that are typical for the circumstances of the pre-trial investigation.

The investigative inspection of the place where the firearms were fired in terms of resolving forensic ballistics issues has the following purpose: 1 - to identify material evidence of the use of firearms - fired bullets, fired cartridge cases and wads, other parts of the cartridge, main and additional traces of a shot, firearms or their parts, which in itself in complex cases requires forensic ballistic knowledge and the use of technical means; 2 - to at least tentatively determine the involvement of the

found objects and traces in criminal proceedings, without which the correct selection and seizure of material evidence is impossible; 3 - accurate fixation of the scene, its environment, location and characteristics of material evidence and all traces of the shot. Shortcomings in the identification and recording of these data cannot be compensated for later by additional inspections due to natural factors of changes in the situation at the scene. In this regard, a thorough (complete and accurate) fixation of the scene in the inspection report, photographs, video recordings, diagrams and drawings is of great importance.

Specialists in the field of forensic medicine and ballistics can provide important assistance to the investigator in examining the scene of firearms use. This is primarily due to the fact that an event involving the use of firearms is almost always complicated by the death of a person, so if there is a corpse at the scene, the participation of a forensic medical expert or doctor in the examination is not only desirable but also procedurally mandatory. Another peculiarity is that working with traces of firearms is quite difficult, diverse and requires qualified assistance to the investigator from a forensic expert. The participation of a specialist in the inspection of the scene is important for the reconstruction of a complete information (trace) picture of the crime. The specialist has at his disposal the entire arsenal of technical means necessary for the detection, fixation, and seizure of ballistic objects. The whole complex of traces found and seized during the inspection may be reflected with varying degrees of completeness in the protocol and its annexes. A specialist plays a significant role in this. With the right approach, each trace or material evidence in the narrative part of the report should contain certain information about the place of its discovery, location, and condition, which is not always fully and accurately reflected by the investigator. A precise description in the report of the situation at the scene, the facts of detection and seizure of traces and other material evidence contributes to the accurate reflection of individual items, damage, traces and their correct assessment. It is the trace evidence specialist who receives more information than the investigator or operational officer. A trace and evidence specialist can resolve issues that are important for further investigation. For example, the suitability of a particular trace for identification, the identification period of the trace; establishing the mechanism of trace formation, as well as which traces were left by the victim and which by the suspect.

The discovery of firearms at the scene of an incident also determines certain peculiarities of this investigative (detective) action. During the inspection of the scene of the incident on the facts of Obstruction of the lawful activities of the Armed Forces of Ukraine and other military formations, involving the use of firearms, the issues of establishing the circumstances and place of the crime, seizing bullets, cartridge cases and other parts of the cartridge, main and additional traces of the gunshot, firearms and its parts are being resolved. Firearms are a source of increased danger and

improper handling of firearms at the place of their discovery may cause an accident. When a firearm is found at the scene, the first thing to do is to examine the weapon itself, make sure that it cannot have been fired spontaneously, and only then can the limits and procedure of the examination be decided, and the planned examination of the entire scene be proceeded with.

Inspecting the weapon before it is discharged is one of the most important stages of the scene investigation. This stage is complicated by the fact that the weapon is still a real source of danger even after it has been fired. In modern automatic weapons, after a shot is fired, the next cartridge is delivered from the magazine to the chamber, and the trigger is cocked. Therefore, if the trigger is pulled carelessly, or if the weapon is malfunctioning, even if it is dropped or shaken, it can fire randomly. The weapon must be held with the barrel pointing upwards, not pointed at yourself or others.

The fixation of weapons begins with their description in the protocol and photographing them in the place and position in which they were found, i.e. at the static stage of the inspection. The report must include the number of the weapon or a separate indication of its absence or signs of destruction, as well as the presence of all parts of the weapon or the absence of some of them. In the static stage of the inspection, in addition to describing the external features and characteristics of the weapon, considerable attention should be paid to the detection of traces on the weapon itself and on the surfaces of surrounding objects.

The most important characteristics of the firearm's condition at the time of its discovery are the functional position of the bolt (front extreme, rear extreme, intermediate), the trigger (discharged, cocked, in an intermediate position); for certain weapons, the position of the trigger on the safety catch, the position of the fire mode switch are fixed. The investigator must take measures to ensure that during the unloading process, the presence of a magazine in the weapon, the presence of unused cartridges in the magazine and the order in which they are located, and the presence of a cartridge or spent cartridge case in the chamber are recorded. The weapon and the magazine are packed separately. Forensic ballistics experts point out that in order to preserve traces of weapon parts on the cartridge case or cartridge, it is necessary to refuse to discharge the weapon at the scene, and to ensure its safe transportation to the place of examination by a specialist, use strong gaskets that are placed between the front cut of the bolt and the rear cut of the barrel channel.

The inspection of individual firearms has certain peculiarities. For example, when inspecting pistols, it is necessary to find out whether the trigger is on the cocked position, whether the safety is on or off, whether there is a cartridge in the chamber, whether the bolt guard is in the rear or front position, whether there is a magazine in the pistol grip, and the number of cartridges is determined

by the holes in the magazine walls, which is indicated in the protocol. Pay attention to extraneous layers on the corrugated surface of the trigger and pistol grip.

When inspecting revolvers, it shall be noted whether the trigger is disengaged or cocked, whether there are cartridges in the barrel, and the barrel shall be left in the position in which it was found. Live ammunition and spent cartridge cases shall not be removed from the chambers of the barrel at the scene. Without rotating the barrel, open the chamber door and count the number of rounds in the chambers and determine the sequence of spent cartridge cases and live rounds. The cartridges and cases are counted clockwise, counting the case or cartridge opposite the firing pin first. If there are live cartridges among several fired cartridges, it is advisable to attach a diagram of the location of the fired cartridges and cartridges in the revolver's chamber to the inspection report.

When inspecting assault rifles and handguns, the position of the bolt, whether the bolt is on the safety, the position of the fire mode switch, the presence of a magazine, the number of rounds in it and whether the bolt carrier is closed.

For rifles and carbines, it is determined whether the bolt is open or closed, whether the trigger is disengaged or cocked, whether the bolt is on the safety, whether there is a fired cartridge case or an unused live round in the chamber, and the number of cartridges remaining in the magazine.

Special care should be taken to identify and preserve fingerprints found on weapons. Often, weapons are covered with a thin layer of lubricant, which is a significant obstacle to the detection and fixation of handprints, so it is better to take measures to preserve the traces on the weapon, protect it from possible damage to the traces during transportation and storage so that their detection and fixation can be carried out by an expert in a laboratory. During and after the examination, measures should also be taken to ensure that no powder residue falls out of the barrel channel. To do this, the barrel of the weapon is held horizontally during the inspection, and after determining the presence of the smell of burnt gunpowder, a cotton swab is inserted into the barrel channel from the muzzle and the muzzle is wrapped in paper.

Traces of the use of firearms in criminal offences against the foundations of national security, which are most often found at the scene, include: projectiles (bullets, buckshot, pellets); shell casings; wads; traces of injury to the human or animal body; holes in various objects, splinters; traces of projectile ricochet; unburned dust particles; traces of soot; traces of thermal effects; muzzle prints on an obstacle. It is very important to find as many traces of the use of weapons at the scene as possible, as together they will allow to draw important conclusions about both the weapon used and the mechanism of the crime.

The type of weapon is usually determined by examining the gunshot marks on the victim's clothing and body, on objects (obstacles). Knowing the type of weapon used, it is possible to

determine the range of traces and material evidence to be searched for at the crime scene and from suspects. For example, if the gunshot wound is caused by pellets or buckshot, i.e. the shot was fired from a smooth-bore weapon, then it is necessary to look for wads, gaskets, pellets, and shell casings at the scene of the shooting. In the case of a rifled weapon, a bullet and a cartridge case must be found. Thus, to a large extent, the specifics of the examination of the scene and the range of material evidence found depends on the type of weapon used.

If a rifled weapon is used, a thorough search for the bullet should be carried out at the crime scene. It may be found in the victim's body or clothing. The presence of a single entry wound indicates that the bullet is in the body. If there is also an exit wound in the victim's body, the bullet may be found in the room or area where the shot was fired. Indoors, the bullet should be searched for in the walls, ceiling, floor, furniture, etc. In cases where traces of ricochet are found on surrounding objects, the search for the bullet itself becomes more difficult, as it can ricochet off several objects and be in the most unlikely place. In this case, it is necessary to focus on all damage, scratches, depressions on objects, chipped wood and holes in objects. It is also worth noting that the appearance of a ricochet trace depends not only on the type of weapon used, but also on the type, flight speed, physical and mechanical characteristics of bullets and obstacles.

The locations of the bullets, all bullet holes and ricochet marks should be recorded in the examination report, diagrammed and photographed. This data can then be used by a ballistics expert to establish the direction of the shot and the location of the shooter.

It is much more difficult to find a fired bullet in an open area. It can be found in the ground, trees, fences, cars, building walls, etc. In some cases, if there is a possibility of the bullet hitting the ground, sand, snow, grass or water, it is advisable to use a metal detector. The great effort associated with the search for a bullet is justified by the importance it has for the possibility of identifying the barrel of a firearm by traces on the bullet.

If the bullet has penetrated an obstacle, the depth of penetration must be measured and the direction of the bullet channel must be determined, which is important for determining the distance from which the shot was fired. Before removing the bullet from the obstacle, it is necessary to make an approximate marking of the location of the bullet hole. In order to avoid damage to the bullet, it must be removed together with the part of the obstacle in which it has lodged. If the bullet is lodged in wood, it is necessary to cut or saw out the piece of obstacle with the bullet hole in the centre. The sawn piece is then split along the fibres and the bullet is removed. The split halves of the wood should be kept for further investigation and to determine the line of flight of the bullet. A bullet can be removed from plaster, brick or cement using a pry bar or metal tube with a diameter 2-3 cm larger

than the diameter of the bullet hole, but the tool should not touch the bullet itself, as traces from the surface of the barrel channel may be destroyed.

The inspection report must include the material of the bullet and its casing, the length of the bullet, its diameter, the shape of the tip and bottom, the colour of the casing and core, markings, the method of fixing the bullet in the cartridge case, the number and direction of the rifling marks, deformations and extraneous layers on the surface of the bullet.

Knowing where the bullet struck the obstacle and determining the direction of the shot, it is possible to determine the likely direction of ejection of the spent cartridge case. The location of the casings helps to determine the location from which the shots were fired. Attempts should be made to locate and recover all the casings. To do this, you first need to establish the location from which the shots were fired as accurately as possible and carefully examine the entire area around it, remembering that the casing may have rolled away sideways or fallen into a puddle, under grass, leaves, etc. Indoors, a cartridge case thrown out of a weapon after a shot can ricochet off surrounding objects, roll under furniture, into cracks in the floor, etc. If the cartridge case is not found on the floor or in open areas, it should be searched for in clothing pockets, inside shoes, in flower pots, etc. For this purpose, metal detectors can be used both indoors and outdoors. If necessary, melt the snow cover on the spot, without collecting it in a pile, as the location of the casing may change with the snow.

The range and direction of ejection of cartridge casings from automatic weapons depends on the design of the weapon and the individual characteristics of a particular weapon, as well as on the conditions of the shooting, the direction of the barrel, the height of the weapon relative to the floor or ground. The report shall include the markings on the bottom of the cartridge cases, their shape, metal colour, length, and the presence of the smell of burnt powder, soot, oxidation marks on brass cartridge cases or rust on steel cases, and the presence or absence of metal shine in the slip marks from the weapon parts.

If several cartridge cases are found at the scene, the inspection report and diagram should record the location of each cartridge case, pack them separately, and indicate the location of each cartridge case on the packaging. Sometimes the casings may be picked up by the perpetrator or by unauthorised persons who first arrived at the scene. In such cases, the fact that there are no shell casings at the scene should be noted in the report as a negative circumstance.

During the examination of the crime scene, attention should also be paid to traces of ricocheting cartridge casings from obstacles. Such marks can be found on walls, ceilings, and furnishings when firing automatic weapons indoors, and in the open on trees, exterior walls of buildings, fences, vehicles, etc. They usually look like arched, shallow scratches. These marks can be used to determine the position of the weapon at the time of the shot. Shell casing marks on objects in

the environment are not often found and recorded during the examination of the scene, but they can be found and should be sought. Accurate recording of the location of the casing mark in the examination report, combined with an examination of the direction of the wound channel in the victim's body and the distance of the shot, can be used to determine the location and position of the weapon at the time of the shot, as well as to determine the location of the person who fired the shot.

The mechanical effect of powder gas pressure affects the object only at close distances, no further than 5-10 cm. It is expressed in the formation of tears in the edges of the entrance hole, and sometimes in the "knocking out" of individual parts of it. In addition to the distance of the shot, the destructive effect of powder gases depends on the type of weapon and the nature of the obstacle itself. This is due to the different velocity, volume and pressure of the powder gases. The more powerful the cartridge, i.e. the larger its powder charge, the greater the volume of destructive power of the powder gases.

Due to their high temperature (over 1000 °C), powder gases can cause heating and even ignition of flammable materials in the barrier. Heating effects from smokeless gunpowder shots are formed around the entrance hole on woolen fabrics at a shot distance of no more than 8-10 cm.

When fired with smokeless powder, the decomposition products of the capsule composition and metal dust that is wiped off the surface of the projectile, barrel and case are carried out of the barrel channel by the powder gases. The colour of gunshot soot is usually grey. The intensity of the tone is manifested in traces from dark grey in the centre to light grey on the periphery. When fired from modern weapons, the soot is deposited no further than 30-50 cm from the muzzle.

In many cases of the use of firearms, a large number of traces of the shot (shot products) remain on the person holding the weapon or in the immediate vicinity of the weapon at the time of the shot. Such traces remain for several days on the hands, face, eyelashes, eyebrows, hair, ears, and in the respiratory tract, in particular in the nasal cavity. These traces can be detected on clothing, gloves, hats and even shoes for a longer period of time. There are modern techniques for detecting gunshot marks on various obstacle objects. It is known that the basis of smokeless gunpowder used in ammunition for modern small arms is nitrocellulose, which produces gaseous nitrogen oxides when burned. After deposition on a damaged obstacle or other carrier objects, nitrogen oxides in the presence of oxygen from the air and water vapour are converted into nitrites, which are detected using a modified Griess-Ilosvay reagent, which is a 1:1 mixture of a 0.6% solution of sulfanilic acid and naphthylamine. In the presence of nitrites, this reagent forms a complex compound that has a red-violet colour. However, such a reaction must be carried out in solution, and therefore only the presence of gunpowder particles can be detected at the crime scene, but not their distribution on the surface of the trace carrier. More detailed research is carried out in the laboratory.

Experts in the field of forensic ballistics and forensic medicine have proposed criteria for determining the relative position of the weapon and the victim at the time of inflicting the gunshot wound by the nature of the traces of gunshot products on obstacles. In the absence of such methods or in the event that no damaging shot products are found at the crime scene, forensic experts who participate in the examination of the crime scene as specialists often make a relevant conclusion only in the direction of the wound channel, which is insufficient. Therefore, the person conducting the scene investigation should be aware that the distribution of soot on the surface of the obstacle, wipe belts, powder grains and metal particles around the entry wounds can be diagnostic criteria in addressing this issue.

For example, a shot from an AK-74 rifle at a 90° angle would be characterised by the shape and relative position of the central and symmetrical lateral soot zones (in the form of butterfly wings) at a distance of up to 3 cm from the muzzle cut; the symmetrical position of the central zone relative to the entrance port and the ring-shaped nature of the wiping belts at a distance of 5 cm to 15 cm. Signs of a shot on the right: the presence of four soot zones - a conical central zone, an oval lateral zone and rounded additional zones, and the inclination of the lateral zone towards the entrance hole. The shot marks on the left differ from the previous ones by the presence of three soot zones - a conical central zone, an oval lateral zone and a rounded additional zone. Signs of a shot from above: five soot zones in the form of a pentagon. Signs of a shot from below: three areas of soot in the form of a shamrock - a conical central area and side areas. In all of these barrel positions, the wiping belts are asymmetrical and extended towards the bullet entry. The angle of inclination of the gun barrel can be determined by the shape of the central soot deposition zone and the wiping belt: as the angle of shot decreases, the angles of convergence of the lateral boundaries of the central soot deposition zone and the wiping belt also decrease; an increase in the angle of shot leads to a decrease in the distance of soot from the centre of the entrance hole. The distance of the shot, regardless of the angle of inclination of the gun barrel, is determined by the change in the distance from the centre of the entrance port to the boundaries of the soot zones. Therefore, the person inspecting the scene should pay attention to and record in detail in the report such characteristic signs of the damaging factors of the shot. Specialists of the forensic unit involved in the examination as specialists can use such common and available methods as stereomicroscopy, X-ray, infrared and ultraviolet rays, and the method of colour prints, which will allow them to identify additional signs of a firearms shot.

Particular attention should be paid to finding weapons, shell casings, sometimes magazines and other objects used in the shooting, abandoned by the perpetrators, in order to detect various traces and layers on them. On the weapon - its barrel, bolt, silencer, trigger and other parts, on live ammunition - biological traces (fatty substance) and traces of papillary imprints can be found. In

particular, such biological traces in the form of a fatty imprint of the skin surface can be found on the butt of a weapon to which the shooter pressed his cheek or held it with his hands. If a rifle with a telescopic sight was used, a fatty trace may also be found on the part of the sight that was in contact with the shooter's eye, which can be used by forensic experts to determine a person's blood type, and using the capabilities of genotypic examination, individual characteristics of a person can be identified.

A common approach to the assessment of traces on fired cartridge cases is based on the fact that after a shot, the cartridge case does not contain fingerprints of the person who held the cartridges or loaded them into the magazine or chamber, as the fatty substance on the surface of the cartridge case burns under the influence of the high temperature of gunpowder combustion. The current level of development of forensic ballistics and the developed methods of examining ballistic objects refute such opinions. Not only foreign, but also domestic forensic scientists widely use in practice the method of detecting handprints on the surfaces of cartridge cases using cyanoacrylic acid vapours. One of the positive consequences of this method is that this reagent not only detects handprints, but also records them. The high sensitivity of cyanoacrylic acid to microscopic amounts of the fatty component of the trace makes it possible to detect and fix handprints not only on ammunition, but even on the cartridge cases after the shot. In addition, there are cases when the fatty substance of the trace does not burn during the shot, but is baked on the surface of the cartridge case due to the high temperature of the gunpowder combustion. Such faintly visible traces can be detected in oblique lighting. To obtain a visible image of the trace, the Razvetka device is used, which is designed to photograph the surface of bodies of revolution (bullets and cartridge cases). The detection and seizure of traces of fingerprint origin on fired cartridge casings, together with the verification of the casings themselves against the forensic records of the bullet and cartridge cases, makes it possible to verify the fingerprint against the arrays of fingerprint records - the trace library and the fingerprint library. At the same time, the handprint found on the cartridge casing and placed in the fingerprint register will be constantly checked against the fingerprint records of persons registered with the fingerprint register, which significantly increases the chances of identifying the person involved in the commission of a firearms crime.

Quite often, crimes are committed with the use of hunting smoothbore weapons - hunting rifles and shotguns converted from hunting rifles. The difference between such weapons and rifled weapons is that the projectile can be not only a bullet, but also a pellet or buckshot or other charge fillers that leave damage to obstacles and the human body over a much larger area. In addition, the fact that a cartridge is equipped with a non-standard multiple projectile (pieces of wire, nail or screw cuttings) makes it much more difficult or even impossible to identify the barrel channel. Shots fired

from hunting weapons leave behind pellets, buckshot, wads, containers and gaskets at the scene. Shell casings are rarely left behind, only in cases where the perpetrator hastily reloaded the gun or the shots were fired from a gun with automatic reloading.

One of the most important requirements for inspecting a scene where a hunting smoothbore weapon was used is to collect as much of the whole pellet or buckshot projectile as possible, which greatly complicates the search process due to the large dispersal area of individual pellets or buckshot. Therefore, it is necessary to inspect not only the main target, but also nearby obstacles and surfaces.

Gunshot damage on wood, glass and metal has some peculiarities. The diameter of the damage on wood is slightly smaller or similar to the bullet calibre. The entry hole in wood has smooth edges where splinters and chips of wood fibres are formed. Rawer wood with a fibrous structure is more rigid, causing the bullet channel to shrink in the direction of the fibres and the bore to become oval. To correctly determine the calibre of the weapon, the rim of the wiping belt must be measured, not the bullet bore. The recognition of bullet and pellet holes in growing wood becomes more difficult with time. With regard to damage on thin and elastic obstacles, it should be noted that the presence of a wipe belt in the hole is not an absolute indication of bullet damage.

Bullet damage on metal usually corresponds to the diameter of the bullet, but if the bullet deforms when it hits the metal, the holes will be much larger. If a bullet penetrates metal at an angle, the hole has an elongated shape, and there is a trace of one-sided friction on the surface of the obstacle from the direction of the bullet's movement.

Gunshot damage on glass has a funnel-shaped shape with an expansion in the direction of the projectile flight, and their size exceeds the projectile calibre. Specific signs of bullet damage to glass include the presence of a ring of small glass fragments that are in an amorphous state around the hole; radial and concentric cracks that extend over a considerable distance from the point where the bullet hit the obstacle. In the case of damage to triplex glass (typically car windscreens), which consists of two or more layers of sheet glass and a celluloid sheet located between them, with a general conical shape of the damage, the damage in the celluloid sheet is somewhat smaller than in the glass sheets.

According to practitioners, when inspecting the crime scene involving the use of firearms, specialists of forensic units deal with two most typical situations. In the first case, weapons, ammunition, bullets, shell casings and traces of firearms use remain at the scene. From the point of view of forensic investigation, this situation is ideal. The specialist has a real opportunity to establish with certainty whether the crime was committed with this particular weapon. However, most often, only fired bullets and shell casings, as well as traces of firearms, remain at the crime scene. In order to solve such a crime in hot pursuit or to formulate investigative versions, it is necessary to know what type and kind of weapon the perpetrators used to commit the crime. In such a situation, the

experience of a forensic expert who assists the investigator in examining the scene of the crime plays an essential role.

Preliminary ballistic expert examination at the crime scene is a specific form of cognition through the use of specialised knowledge. However, this is not the only way to establish evidentiary facts in criminal proceedings, which involves a direct examination of the crime scene. The person conducting the pre-trial investigation examines the crime scene, material evidence relating to the environment, the corpse found at the scene, and conducts the necessary investigative experiments. These investigative actions at the scene are important parts of the pre-trial investigation and the process of proof. However, the investigations carried out by investigators at the scene, even with the participation of a specialist, do not ensure full disclosure and sufficient procedural documentation of some evidentiary facts. The investigator conducts a review and cannot resolve special issues, and the specialist only assists the investigator in research and does not create independent procedural sources of evidence.

The main reason for conducting preliminary ballistic research at the scene is the very nature of the object under investigation - a special two-way relationship between the scene and the event. The relationship between the situation (static element) and the mechanism (dynamic element) and its impact on the methodology of expert research is as follows:

- when making any shot, whether prepared in advance or sudden, the person making the shot is situationally related to his or her location, the location of the victim(s), possible obstacles between them and other circumstances. In this regard, the situation leaves its mark on certain events

- when shots are fired, quite persistent traces are left at the scene - damage, projectiles submerged in an obstacle, blood splashes, parts of soft tissue, etc. Thus, the event of the crime also leaves its mark on the scene;

- the process of trace formation during a shot is usually uncontrolled, so a certain number of traces fall out of the shooter's field of vision, and he or she does not have time or cannot distort or destroy them.

The research conducted by specialists at the scene of an incident is caused by a number of specific features, including the need to examine all traces of a shot, including bulky objects; the entire environment as a necessary aspect of the event; conducting research in a short time; visibility both in relation to the research itself and its preliminary results.

Expert research at the crime scene or event after the appointment of a forensic examination should be carried out in the following cases:

- when, in order to resolve the issues raised to the specialist, it is important to examine not only individual material evidence - firearms, objects with traces of a shot, but also the very

environment of the place where the shots were fired - the terrain, size and features of the room, its walls, ceiling, floor, furniture in the room, etc;

- when it is necessary to study the relationship between gunshot marks on different objects for the purpose of the investigation;
- when material evidence with gunshot marks cannot be delivered from the crime scene due to their bulkiness, the risk of damage to the marks during transport.

Conducting investigations at the crime scene is important for addressing a number of issues:

- how many shots were fired at the scene;
- if there are several shots, what is their sequence, which of the shots was fired first;
- in which direction the shot(s) were fired;
- the trajectory of the bullet at the scene, from where the shots were fired;
- the relative position of the shooter(s) and the victim at the time of the shot.

In all cases, the resolution of these issues will also require laboratory examination of material evidence or data obtained as a result of the investigation at the scene. In some cases, it is advisable to have the suspect present at the scene during the preliminary investigation so that the expert, with the investigator's permission, can detail and correctly assess his or her testimony.

One of the important and rather problematic issues that arise in the course of examining the scene of an incident involving the use of a firearm is determining the direction and distance from which the shot was fired. This is facilitated by the detection of signs of entry and exit holes and other traces. On fragile solid barriers - brick, concrete walls, glass - the exit hole is larger than the entrance hole and has a cone shape in cross-section, which expands in the direction of the bullet's flight. In plastic obstacles, which can include objects made of metal and wood, the diameter of the entrance hole is close to the bullet calibre. In elastic products (clothing materials), the entrance hole is usually smaller than the bullet calibre or is completely absent (rubber products), because the elastic barrier stretches upon impact, allows the bullet to pass through, and then the hole contracts again, creating a pinpoint damage. The difference between the size of the exit hole and the entrance hole is more pronounced the greater the thickness of the barrier. Entry holes on clothing have a fabric defect (missing part) that is smaller than the bullet calibre. The size of the exit hole is usually larger than the entrance hole. The distance of a shot is the distance in a straight line between the muzzle of the weapon facing the obstacle and the entrance hole in the obstacle. In forensic science, shot distances are conventionally divided into close and non-close. A type of close shot is a shot at point-blank range. The most reliable sign of a point-blank firearms shot is an imprint of the muzzle of the weapon on an obstacle - the so-called "stanz-mark" ("stamp-imprint"). Powder gases, penetrating the skin, lead to the formation of a local swelling, which impulsively bulges towards the muzzle of the weapon

and the surface of the skin is pressed against the metal with great force. As a result, an abrasion or haemorrhage (bruise) occurs on the skin, sometimes repeating the shape, size and design features of the muzzle of the weapon. The damage can have very clear contours and is then called a "stanz-mark". Most often, "stanz-marks" are formed on areas of the body where flat bones are located close to the skin (skull vault, shoulder blades, etc.), as powder gases in such cases mostly act on the skin in the opposite direction, i.e. towards the muzzle of the weapon.

Shots from close range are considered to be those that, when examined, reveal additional traces of the accompanying factors of the shot. Shots fired from a non-close range do not leave additional traces on the obstacle. Such issues are usually resolved on the basis of the results of a laboratory study of traces of physical and chemical phenomena that occur as a result of the shot. For this purpose, an impressive arsenal of technical means and methods is used - from contact diffusion to neutron activation and atomic absorption analyses. However, modern devices, despite their high sensitivity, have a number of drawbacks that make it possible to reliably determine the distance only within the close range of a shot. For example, for a rifled handgun, this is usually about 1.5-3 metres. The distance of a close shot at the scene of an incident is determined, with certain assumptions, by the tables of maximum distances of close shot traces for individual weapon models. For example, in the case of a close shot from a 7.62 mm AKM or SKS, tears in clothing fabrics at a distance of 7-10 cm, skin - up to 5 cm, soot on light fabrics at a distance of 30-35 cm, a significant amount of gunpowder particles and metallisation at a distance of 50-70 cm are observed. When fired from a 5.45 mm AK-74 with a compensator, tissue tears occur at a distance of up to 2 cm, no skin tears occur at all, soot deposits on light tissue remain at a distance of up to 30 cm, and individual dust particles and metal particles remain only at a distance of 75-100 cm. After a shot from a PM, tears in clothing fabrics occur at a distance of 1-3 cm, skin - no more than 1 cm, soot is deposited at a distance of 25-30 cm, numerous dust particles and metal particles - 30-40 cm. In the case of a close shot from a 12-gauge hunting rifle, tears in tissue occur at a distance of up to 7 cm, skin - up to 5 cm, soot is deposited at a distance of 50 to 100 cm, and single dust particles and metal particles can be detected at a distance of 2-3 m.

In the case of determining the distance within the distance of a non-close shot, when the affected obstacle is mainly affected by a firearm (bullet), the possibilities of physicochemical laboratory methods are sharply reduced, since the related products of the shot do not reach the affected obstacle, and if there are cases of detection of related products of the shot at short distances (3-5 m), this can only be a consequence of their transport directly by the projectile and its subsequent interaction with the obstacle. Therefore, the distance of a shot fired beyond the independent effect of the related products is defined as a "short distance". A specific distance expressed in units of

measurement (metres, centimetres) is not established in such cases, because the dynamic processes of shots, even those fired from the same weapon and within a short period of time, are influenced by many factors, including microscopic differences in the amount of powder charge, wind strength and direction, air humidity, the angle of impact of the projectile on the obstacle, etc.

In cases where shot was fired, it is possible to determine shot distances by the size of the diameter of the pellet deposit on the obstacle, since the diameter of the pellet spread on the obstacle will be larger the greater the shot distance. For this purpose, specialists have drawn up graphs, nomograms and tables obtained as a result of experimental firing. They cannot be used as a basis for categorical conclusions, but they allow you to navigate the shot distance by the shot pellet.

Sometimes, as a result of a shot from a long distance, grey deposits, similar to soot from a close shot, form on the skin in the area of the entry wound or on the second layer of clothing. The main difference between this layer and close-range soot is the absence of traces of close-range soot on the first layer of clothing.

Expert practice is aware of a large number of scientific developments in which experts in the field of forensic ballistics consider the issue of determining the distance within a single bullet shot from a short distance. Such studies have been carried out both in Ukraine and abroad, in particular, scientific developments by V.E. Berger, L.D. Klymenko, A.F. Lisitsyn, Y.V. Mishin, L.F. Savran, M.O. Sonis and others are devoted to these issues. However, the application of the developed methods is not frequent in forensic and forensic medical practice due to certain difficulties and the need for special skills of a specialist. And although in the vast majority of cases, firearms homicides are committed from a distance of more than 3-5 m, specialists, given the insufficient effectiveness of existing methods, are forced to abandon attempts to establish a specific shot distance.

However, the search for specialists in this area continues. For example, specialists at the Kharkiv Medical Academy of Postgraduate Education have developed mathematical models for determining the distance of a shot from a smoothbore weapon for six brands of bullets with polymer components. The seven most significant factors of trace formation were identified: soot particles, gunpowder grains, polymer substances, separating bullet parts, cardboard gaskets and felt wads. It has been established that the combination of traces and damage caused by these factors, together with the general appearance of the entrance bullet holes, are individual for each bullet brand and distance of the shot, which allows them to be considered diagnostic criteria.

As a conclusion, it should be noted that the current possibilities of knowledge of technical forensic methods allow experts (specialists) to apply the methods developed by specialists to model the trajectory of a bullet by damage in an obstacle using a laser. According to experts, the experimental studies conducted, as well as the implementation of their results in operational,

investigative and expert practice, have shown that portable helium-neon lasers such as LG-78, LT-127, and CRT-6 are quite favourable for determining the distance of a short-range shot. We believe that it is advisable to use these devices to conduct research at the distance of a direct shot. Usually, this distance for different samples of handguns is in the range of 25-150 m. The trajectory of the bullet in this area is as close to a straight line as possible and can be easily modelled using a laser beam. In this case, the generator, as the active element of the laser, will simulate the barrel of the weapon, and the laser beam will simulate the trajectory of the bullet in the area of the direct shot. As a conclusion, it should be noted that the current possibilities of knowledge of technical forensic methods allow experts (specialists) to apply the methods developed by specialists to model the trajectory of a bullet by damage in an obstacle using a laser. According to experts, the experimental studies conducted, as well as the implementation of their results in operational, investigative and expert practice, have shown that portable helium-neon lasers such as LG-78, LT-127, and CRT-6 are quite favourable for determining the distance of a short-range shot. We believe that it is advisable to use these devices to conduct research at the distance of a direct shot. Usually, this distance for different samples of handguns is in the range of 25-150 m. The trajectory of the bullet in this area is as close to a straight line as possible and can be easily modelled using a laser beam. In this case, the generator, as the active element of the laser, will simulate the barrel of the weapon, and the laser beam will simulate the trajectory of the bullet in the area of the direct shot.

Establishing the time of the shot is of great importance for the pre-trial investigation of criminal offences against the foundations of national security. This question arises already during the inspection of the scene. The problem of determining the age of a shot has long attracted the attention of domestic and foreign researchers. Various physical and chemical methods have been used to solve it: magnetometric, X-ray, colourimetric, atomic absorption spectroscopy and others. Other methods were also used to determine the age of the shot: by analysing rust in the barrel of the weapon, by microanalysis of dust on various parts of the weapon, etc. The results obtained did not meet the reliability criterion. It should be noted that chemical methods of analysis were used mainly for the qualitative and quantitative determination of nitrite in the scale of the barrel and spent cartridge cases. However, the results obtained were too contradictory and uncontrollable, as they depended on the number of shots fired, the condition of the barrel channel, the conditions of cleaning, lubrication, storage of the weapon, etc. In contrast, a modern method using spectrophotometry provides better results. The developed research methods make it possible to determine the age of a shot for hunting weapons within 14-20 days. It is on the same principle that an express method for determining the age of a shot has been developed, which can be used directly during the examination at the scene. To this end, indicators have been developed that look like a glass tube with marks filled with a white

indicator mass. As a result of the interaction of the reagent with nitrogen oxides, which are sampled from the barrel channel or cartridge case, the colour of the indicator tube changes to blue-lilac. This rapid method is effective in the case of preliminary examination of objects within four days after the shot was fired.

Thus, the assistance of forensic experts and specialists during the investigation (detective) action in the investigation of criminal offences against the foundations of national security is a prerequisite for the investigator to successfully use knowledge that enables the investigator to correctly identify traces, various objects and the situation on the ground during the inspection of the crime scene, which will be important for further research of ballistic objects by a specialist in the framework of forensic examination. The correct and complete reflection of such circumstances in the protocol of the investigative (detective) action also affects the objectivity of the pre-trial investigation in criminal proceedings and the possibility of making the right decision during the trial.

It is during the inspection of the crime scene, in the investigation of criminal offences against the foundations of national security, depending on the traces of firearms and other material evidence collected on ballistic objects, in particular, traces of firearms and other material evidence, the investigator may subsequently engage an expert and appoint forensic ballistics, forensic medicine, forensic biology, fingerprinting and other types of expertise for their in-depth examination.

References:

Kapil Kumar Nagwanshi, Amit Kumar Gupta, Tilottama Goswami, Sunil Pathak and Maleika Heenaye-Mamode Khan. Human footprint biometrics for personal identification using artificial neural networks. *International Journal of Biometrics* Vol. 15, No. 3-4 2023 pp. 272-290. https://doi.org/10.1504/IJBM.2023.130634

Brajesh Kumar Singh, Ravinder Kumar and R. Rama Kishore. LB and LT feature approach to personal identification using finger knuckle image biological trait. International Journal of Electronic Security and Digital Forensics. Vol. 13, No. 4. 2021, pp 445-459 https://doi.org/10.1504/IJESDF.2021.116016

Xiangyang Wang. Application of automatic fingerprint identification algorithm in criminal investigation. *International Journal of Web Engineering and Technology* Vol. 17, No. 3. 2022. pp. 278-295. https://doi.org/10.1504/IJWET.2022.127874

John Songa, Theodore V. Vorburgera, Wei Chua, James Yenb, Johannes A. Soonsa, Daniel B. Otta, Nien Fan Zhang (2018) Estimating error rates for firearm evidence identifications in forensic science. *Forensic Science International*. Volume 284, March 2018, Pages 15-32 https://doi.org/10.1016/j.forsciint.2017.12.013

Melnyk R.V., Goldinsky I.A., Gamera V.A., (2016) Forensic investigation of firearms. Legal scientific electronic journal.№5/2016, c. 134-137 URL: http://lsej.org.ua/5_2016/40.pdf *(date of access 01.02.2024)*

Tsyganov S.M., Trotsenko A.M., (2019) Specific conditions of forensic research of homemade firearms in Ukraine. Bulletin of the Chernivtsi Faculty of the National University "Odesa Law Academy" Release №3. 2019. c. 149-157. URL: http://jes.nuoua.od.ua/archive/3_2019/16.pdf *(date of access 01.02.2024)*