

Glock through the generations – an analysis of the impact of design changes in forensic firearms examination

Warr Krzysztof Szerszeń, MSc Eng.

Forensic Laboratory of the Provincial Police Headquarters in Gdańsk

ORCID 0009-0003-0797-7420

e-mail: krzysztof.szerszen@gd.policja.gov.pl

Capt Robert Arciszewski, MSc Eng.

Forensic Laboratory of the Provincial Police Headquarters in Gdańsk

ORCID 0009-0004-7464-1430

e-mail: robert.arciszewski@gd.policja.gov.pl

Abstract

The aim of the article is to present the impact of design changes in Glock pistols on the class characteristics reproduced on cartridge cases and bullets, and the impact of modifications to the trigger and firing mechanism on the results of the analysis of the firearm's trigger and firing mechanism. The discussion is preceded by an outline of the changes in the design of the individual generations of Glock pistols, and in particular a presentation of the significant design differences and technological changes between the third and fifth generations.

Keywords: Glock, connector, trigger and firing mechanism, class characteristics, rifled bore, GLOCK Marksman Barrel, firing pin tip, breech face.

The history of the Glock family of pistols begins in the early 1980s, when the Austrian Ministry of Defence decided to modernise the personal weapons of its soldiers. The main reason was to replace obsolete firearms dating back to the Second World War; at that time the Walther P38 and the Browning Hi-Power were still in service. The Austrian Ministry of Defence drew up a list of as many as seventeen technical and tactical requirements that the new pistol model had to meet. These requirements included, among others: calibre – firing standard 9×19 mm NATO ammunition, high magazine capacity, ergonomics, corrosion resistance,

drop resistance, simple disassembly without tools, a small number of parts and low weight, ease of handling – a minimum number of manipulations before firing, and passing a test with an overpressure proof cartridge [3].

In 1980 Gaston Glock founded GLOCK GmbH and, together with the engineers he employed, set to work on a pistol that would meet the requirements laid down by the Ministry. Thus, in 1980, the semi-automatic pistol designated Pistole 80 or P80 was born; in 1982 it took first place in the tender, emerging as the clear winner, and in 1983 it was introduced into the Austrian armed forces.

News of the innovative pistol with a polymer frame and a proprietary triple safety system called the Safe Action® System spread quickly. The system made it possible to dispense with the conventional external manual safety lever while still meeting safety requirements. The pistol had three automatic safeties, which remained engaged until the trigger was pressed. The first – a lever located inside the trigger (trigger safety), which, when pressed, unlocks the trigger itself; the second – a firing pin safety that blocks the movement of the firing pin until the trigger bar has moved as a result of the trigger being pressed; the third – a drop safety that holds the firing pin in the rear position on its catch until the trigger is fully pressed.

As a result, numerous European armed, military and police formations became interested in the new, innovative pistol and began to acquire it and bring it into service. A civilian version, named the Glock 17, followed. The first-generation Glock was produced in 1982–1987 [4]. The Glock Gen 1 had a firing pin tip together with a firing pin aperture of rectangular cross-section shaped in the breech face, and a bore with polygonal rifling instead of conventional sharp-edged lands and grooves. The advantages cited for this bore design were a better gas seal, which made it possible to achieve higher bullet velocities, easier cleaning and slower barrel wear.

In 1988–1997 the second generation of the Glock was introduced; visually, it differed in an improved grip and a change in its texture. In terms of design, the recoil spring was strengthened and improved in the second generation by modifying its geometry, and the magazine and its follower were also redesigned. A numerical marking was also introduced in the lower part of the frame under the barrel, in the form of a metal plate bearing the serial number [5].

The third generation of the Glock was produced in 1998–2009; an accessory rail was added under the barrel, making the pistol compatible with the mounting of a torch or a laser aiming device. The grip was improved by the addition of finger grooves and a thumb rest shaped in the upper part of the grip, while the grip texture became more pronounced. The third generation also brought a third locking block pin, which took over part of the recoil force and relieved the load on the trigger pin, which was intended to improve the service life of the firearm. Production of this generation has not been fully discontinued; models such as the 17, 18, 18C, 19 and 25 are still being produced [6].

In 2009 the fourth generation of Glock pistols was launched, bringing a change to the recoil spring assembly. The spring was divided into two segments, one of larger and the other of smaller diameter. This modification reduced recoil and improved the durability of the assembly, particularly in prolonged use. A reversible magazine catch was introduced, as well as the possibility of adapting the grip size to the shooter's hand through interchangeable backstraps; production of this generation ended in 2017 [7].

The fifth generation premiered in the same year; it dispensed with the finger grooves moulded into the grip that had featured in the two previous generations. The

magazine well was flared, an ambidextrous slide stop lever was fitted, additional front serrations were introduced on the slide, and the slide surface and the barrel received an nDLC finish, which provides better resistance to wear and corrosion. The MOS (Modular Optic System) was adopted, in which a metal plate is fitted behind the rear sight; once the plate is removed, an optical sight can be mounted. The fifth generation introduced the GLOCK Marksman Barrel (GMB), a type of barrel rifling developed and introduced by Glock. The GMB is an improved version of the polygonal barrel in which a rifling profile has been added along the sides of the lands of the rifled bore. According to the manufacturer, this solution provides a better seal around the bullet travelling through the barrel and improves accuracy. Bullets fired from a barrel with GLOCK Marksman Barrel rifling also bear more distinctly reproduced class and individual characteristics, which improves the identification properties of a bullet recovered at the scene and the matching of a pistol to it [8].

The latest, sixth generation premiered in 2026; the models produced in this generation are the 17, 19, 45 and 49. The current generation has all the updates brought by the fifth generation; the changes introduced in this generation are a change in grip texture, an extended beavertail and the application of the MOS system to all new models in the generation [9].

In 2017 Glock entered another competition, this time for a US military programme aimed at selecting a new service pistol for the US Army. The Austrian company's response was the 19X model. It is a "crossover" design combining the slide of the Glock 19 with the frame of the Glock 17, which correspond respectively to the smaller dimensions of the pistol and the larger magazine capacity. The pistol, produced exclusively in Coyote Brown, was fitted with metal night sights and a lanyard attachment point [10]. Although the competition was won by SIG Sauer with the P320, the 19X model was launched on the civilian market owing to its enormous success. About nine months after the premiere of the 19X, which took place at the beginning of 2018, the Glock 45 was presented. This model is adapted to police requirements, including, among other things, a black finish, and is manufactured to the fifth-generation specification [11]. There are also so-called transitional models on the market, combining design features of the generations that have changed over the years.

Examination of identification characteristics



Fig. 1. Polygonal rifling, Gen 3 (left) – Marksman Barrel rifling, Gen 5 (right), authors' own work

As the Glock generations developed rapidly, the class characteristics left on the surfaces of bullets and cartridge cases also changed. The change in the type of barrel rifling in the fifth generation from polygonal to the GLOCK Marksman Barrel resulted in more individual characteristics being left on bullets. In 2019 a study was published in which four cartridges were fired from each of nine fifth-generation Glock "17" pistols, and the bullets were then identified on the basis of reference material. Working with the Evofinder system, the authors of the experiment correctly assigned all the fired bullets to the pistols from which they had been fired. In the second part of the experiment, 500 bullets were fired from a single Glock "17", and every 50th bullet was taken for identification examination. The examination showed that wear of the barrel in service does not significantly affect the quality of the preserved identification characteristics [1].

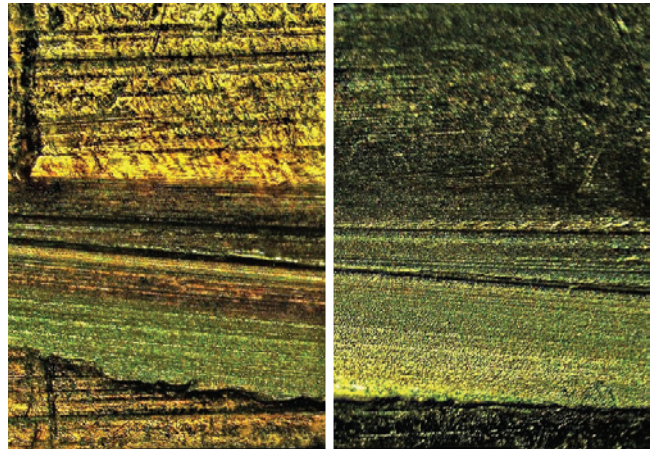


Fig. 3. Side-by-side comparison of the characteristics of a GMB-type rifled bore on bullets fired from a Glock Gen 5 pistol, authors' own work

The shape of the firing pin and its aperture was also modernised and, consequently, the class characteristics of the firearm reproduced on the fired cartridge cases changed. From the first to the fourth generation it had a rectangular cross-section, whereas the fifth generation adopted a shape with rounded edges. This change was intended to improve the strength of the breech face and to achieve a more even distribution of forces after firing, which leads to slower wear of this component. Figure 4 shows a side-by-side comparison of the breech faces of the third and fifth generations.

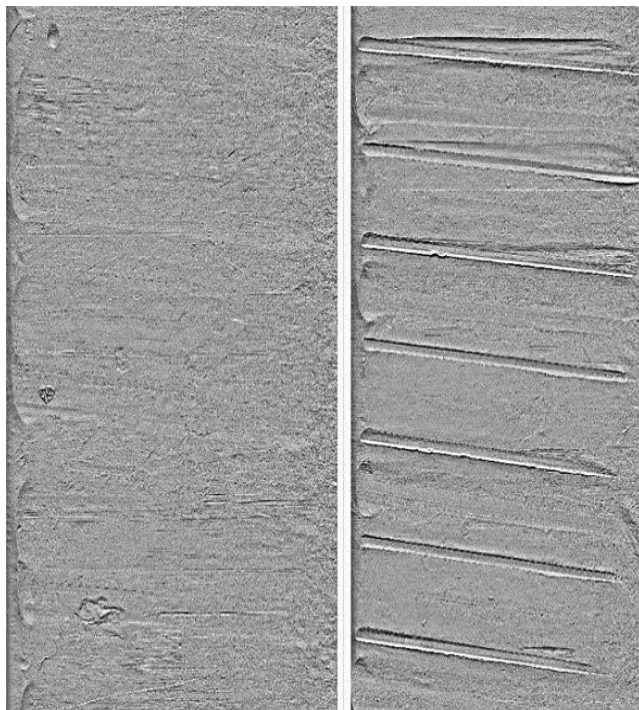


Fig. 2. Barrel marks reproduced on a bullet fired from a Glock Gen 3 (left) and Gen 5 (right), scanned in BalScan, authors' own work

Figure 2 shows the bullet surfaces scanned in BalScan: on the left, the marks reproduced on a bullet fired from a Glock Gen 3 with polygonal rifling; on the right, the marks left on a bullet fired from a Glock Gen 5 with GMB-type rifling. Using the tools of the BalScan device, the three-dimensional solids forming the bullet were unrolled onto a flat surface. On the surface of the bullet fired from the fifth-generation pistol, in addition to the reproduced marks of the rifled bore itself, the rifling profile delimiting the widths of the lands is also visible, which greatly facilitates individual identification in the comparative examination of bullets by making it easier to align the corresponding lands and to indicate individual characteristics. Figure 3 shows an example of a side-by-side comparison of the characteristics of the GLOCK Marksman Barrel rifling of a Glock Gen 5, reproduced on the compared bullets during microscopic examination.

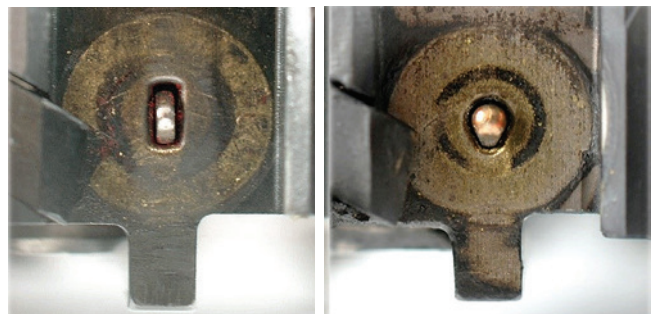


Fig. 4. Breech face, Gen 3 (left); breech face, Gen 5 (right), authors' own work

The third-generation breech face leaves a characteristic rectangular or envelope-like shape on the primer of the cartridge case. In the fifth generation, this shape is a round mark with an edge elongated on one side.

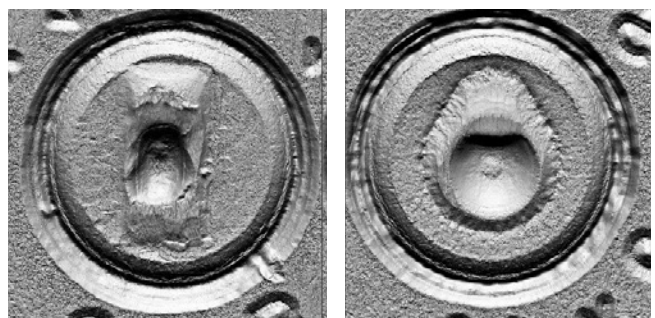


Fig. 5. Breech face mark and firing pin impression, Gen 3 (left); breech face mark and firing pin impression, Gen 5 (right), scanned in BalScan, authors' own work

The role of the connector in the trigger mechanism

The connector in the trigger mechanism is responsible for disconnecting the trigger bar from the firing pin during firing and for ensuring semi-automatic fire only. When the trigger pull begins, with a cartridge already chambered, the first of the three safeties – the trigger safety – is released. The movement of the trigger bar towards the rear of the slide then moves the firing pin in the same direction and subsequently shifts the safety lug on the trigger bar, disengaging the firing pin safety. At this point the firing pin is fully cocked, and the connector, by directing the trigger bar downwards, disengages the drop safety. In the next stage of the trigger movement, the firing pin lug slides off the trigger bar lug and the firing pin tip strikes the primer of the cartridge, i.e. the shot is fired. After the shot, there is the so-called trigger over-travel, i.e. the distance travelled by the trigger from the shot until it comes to a complete stop [2].

Firearm owners modify their weapons to suit their own needs; most often these are modifications that improve parameters such as precision, consistency or the rate of fire. Replacing the connector is a minimally invasive, reversible and quick modification; it reduces the trigger pull weight from the factory 26 N to about 14 N. The cause of the difference is the smaller angle of inclination of the surface along which the trigger bar moves during the trigger pull.



Fig. 6. From left: GHOST connector, source: <https://besthunters.pl/> accessed on 26 August 2026, where 1 – the surface along which the trigger bar moves; 2 – TCT, Trigger Control Tab. Factory connector, source: <https://coltwroclaw.pl/> accessed on 26 August 2026; part of the trigger mechanism showing the trigger bar and the connector surface along which it moves (mechanism fitted with the factory connector)

Figure 6 shows a connector for the Glock trigger mechanism manufactured by Ghost. For comparison, the factory connector is shown in the middle part of the figure [12]; the part of the connector marked with the number 1 is the surface along which the trigger bar moves. The figure clearly shows the difference in the angle of inclination of this surface between the factory and aftermarket components. Marked with the number 2 is the Trigger Control Tab, a connector feature patented by Ghost that limits trigger over-travel. Connectors with an unfinished TCT are also available on the market; its length must be adjusted to the user's needs before final assembly, and this solution practically eliminates trigger over-travel.

The Firearms Examination and Ballistics Unit of the Forensic Laboratory of the Provincial Police Headquarters in Gdańsk analysed two trigger and firing mechanisms, the first fitted with a factory connector and the second with a Ghost connector. The examination showed that replacing the connector produced a difference of about 12 N. The graphs below show the force curve along the travel of the trigger and the components connected with it. Graph No. 1 – the mechanism with the factory connector – shows the trigger overcoming the firing pin safety and, at a later stage, the final cocking of the partially pre-tensioned firing pin, up to the moment of firing and the over-travel. The curve of graph No. 2 is close to linear: the smaller angle of the surface along which the trigger bar moves means that considerably less force is needed to fire a shot.

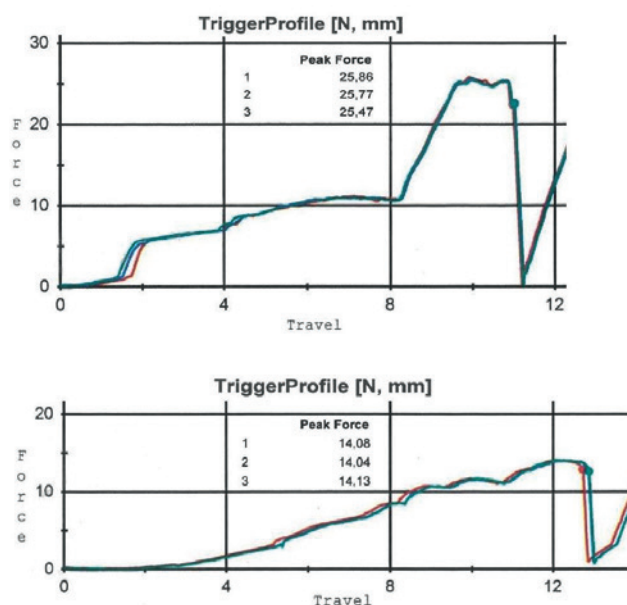


Fig. 7. Graphs showing the force curve along the trigger pull travel with the factory (upper graph) and aftermarket (lower graph) connector, authors' own work

Analysing the operation of the trigger mechanism shows how its individual components interact – this is particularly evident from the wear marks on firearms that have been in use for some time. Further modifications affecting the smoothness of the trigger mechanism involve polishing the mating surfaces of its components. Such modifications change the characteristics of the mechanism. The trigger action becomes smoother and more linear.

Summary

The success that Glock achieved with the launch of the very first generation permanently strengthened the brand's position on the market. Each successive generation brought updates and improvements based on an analysis of the previous models, which translated into greater reliability, safety and ergonomics. The introduction of the GLOCK Marksman Barrel rifled bore greatly facilitated forensic firearms examination. The

connector replacement described above, on the other hand, is one of the easier and quicker modifications affecting the trigger pull weight, and it should be taken into account when analysing the trigger and firing mechanism. In addition to the physical replacement of components, attention should also be paid to the polishing of the mating components of the trigger and firing mechanism, which affects the operating characteristics of the entire assembly. Lower surface roughness means lower frictional resistance at metal-to-metal contact, so the components of the assembly interact more smoothly. This allows greater precision when firing, but also allows conclusions to be drawn during firearms examination that the mechanism operates with less resistance than specified by the manufacturer.

References, websites

1. Christen, C. S., Jordi H. R. (2019). Individuality testing of new Glock pistol barrels "Marksman Barrel", Forensic Science International. Volume 295, pp. 64–71.
2. Autoryzowany serwis Glock w Polsce [Authorised Glock service centre in Poland], Instrukcja obsługi i eksploatacji pistoletów Glock [Operating and maintenance manual for Glock pistols].
3. <https://eu.glock.com/en/explore-glock/glock-history>
4. <https://eu.glock.com/en/products/pistols/g17>
5. <https://glockhistory.com/what-gen-is-my-glock>
6. <https://eu.glock.com/en/technology/previous>
7. <https://eu.glock.com/en/products/pistols/g17-gen4>
8. <https://eu.glock.com/en/products/pistols/g17-gen5>
9. <https://eu.glock.com/en/products/pistols/g17-gen6>
10. <https://eu.glock.com/en/products/pistols/g19x-gns>
11. <https://eu.glock.com/en/products/pistols/g45>
12. <https://besthunters.pl/przerywacz-ghost-3-5-rocket-do-glock-gen-1-4.html>