

# Ballistic Imaging: Not Ready for Prime Time

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No. 160

Wednesday, April 30, 2003

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## Introduction

Following the sniper attacks that plagued Washington, D.C., Maryland and Virginia in the early fall of 2002, gun control advocates intensified their demands that the federal government develop a "ballistic fingerprint" database. Legislators in several states and in Congress, including long-time gun control advocate Sen. Charles Schumer (D.-N.Y.), have proposed bills requiring gun manufacturers to test fire all new guns and to retain the cartridge case and bullet images. Some proposals would require manufacturers to supply the test information to a central agency, such as a state bureau or the federal Bureau of Alcohol, Tobacco, Firearms and Explosives (BATFE), while others would have manufacturers store and maintain the data themselves.

"A ballistic image database would be unreliable and expensive, would solve few crimes and would divert scarce resources from other crime-fighting resources."

Gun dealers, wholesalers and manufacturers keep sales records and serial numbers pursuant to the Gun Control Act of 1968. In theory, if a cartridge case or bullet was found at a crime scene and a supercomputer matched it to a particular gun, law enforcement officials would be able to track the gun from the manufacturer to the initial purchaser. If the purchaser was the criminal, the crime would be solved. If the initial purchaser had sold the gun - rather than losing it to a thief - and remembered the second purchaser, the police might have a lead.

This system sounds good in theory. However, the best evidence is that a ballistic image database would be unreliable and expensive, would solve few crimes and would divert scarce resources from other crime-fighting programs.

## What Is Ballistic Imaging?

FIGURE I

## Firearm Parts that May Leave Ballistic Marks on Ammunition



Source: Jeffrey Scott Doyle, "Firearms Illustrations," firearmsid.com.

Ballistic imaging captures and stores a digital photograph of the striae (fine stripes) and other tiny marks on bullets and cartridge cases. Some gun control advocates refer to ballistic imaging as "ballistic fingerprinting," but this is misleading. Fingerprints are immutable. Ballistic markings can be made by several parts of a gun; they change over the life of a gun and can be easily altered by the gun owner.

"Only bullets used in rifles and handguns produce useful ballistic images."

**Barrel Rifling.** One way ballistic markings are created is by the spiraling grooves, or rifling, cut into the inside of the barrel of most rifles and handguns to make the bullet spin. (Spinning stabilizes the bullet in flight so that it travels a straighter path.) [See Figure I.] The grooves and the raised surfaces between them, called "lands," leave striae on the bullet. Microscopic imperfections in the gun barrel increase with wear and leave marks on the bullet.<sup>1</sup> Of course, if a bullet deforms or is otherwise damaged when it hits a target, which often occurs, the ballistic images are much more difficult to read.<sup>2</sup>

Only bullets used in rifles and handguns produce useful ballistic images. Shotguns fire many small pellets at once. These pellets do not expand to the diameter of the barrel and therefore are not marked by it.

**Marks Left by Other Parts.** An unfired cartridge consists of a cartridge case that contains the bullet, the gunpowder and a primer. When a shooter pulls the trigger, the firing pin strikes the primer, starting the reaction that ignites the gunpowder. The expanding gases created by the burning gunpowder propel the bullet out of the cartridge case and down the barrel. When the cartridge has been fired, marks are left on the now-empty cartridge case and its spent primer by the firing pin, the bolt breech face, and the interior of the firing chamber. In semiautomatic guns, marks also are left by the extractor that assists in removing the expended case from the firing chamber and by the ejector that expels the case from the gun.<sup>3</sup>

Usually, no ejector markings remain on guns that require the shooter to manually remove the cartridge case; these include revolvers and derringers, single-shot firearms, and double-barreled rifles and shotguns.<sup>4</sup> Semiautomatic guns automatically expel used cartridge cases, which criminals often leave behind. They are much less likely to leave their cartridge cases at the crime scene if they have to remove them manually.<sup>5</sup>

"A ballistic examiner must make the final judgment regarding both bullets and cartridges"

**Computer Matching and the Ballistic Examiner.** A ballistic examiner must make the final judgment regarding both bullets and cartridge cases.<sup>6</sup> His determination is subjective, based on his professional experience - in contrast to DNA matching, which is objective.<sup>7</sup> Computer ballistic image matches are not currently accepted as evidence in court without a final judgment from a ballistic examiner.<sup>8</sup> The manual microscopic examination of several possible matches can take several hours.

**Bullets and Cartridge Casings.** In contrast to bullets, cartridge cases do not strike a target and thus are not deformed by impact. Case imaging is much better than bullet imaging at achieving "cold hits" - linking two items not already suspected to be linked.<sup>9</sup> Cartridge case images change more slowly than do bullet images as a result of normal gun use. Accordingly, preliminary computer matches are easier to perform. Still, a ballistic expert must examine the image and make a subjective judgment.

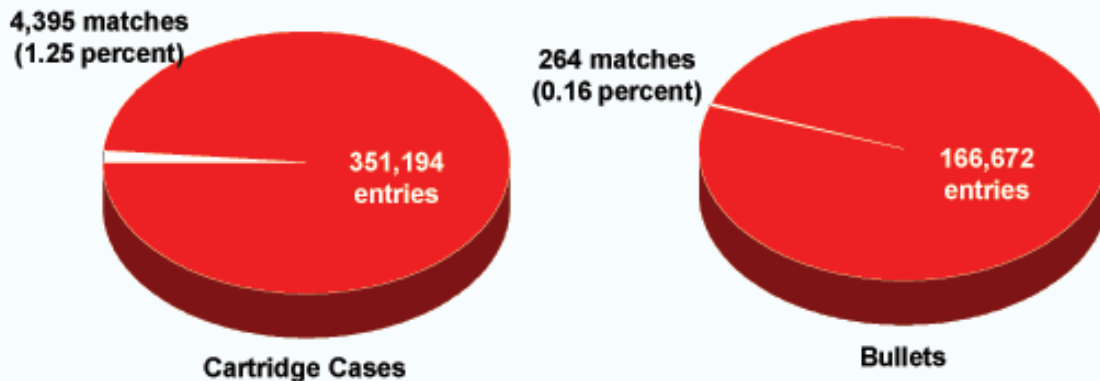
Guns made by the Glock Company and others produce quite distinctive impressions on cartridge cases.<sup>10</sup> Other guns produce useless casing images. For example, the markings on the cases of the tiny rimfire cartridges used in .22 and .25 caliber guns are much less forensically useful.<sup>11</sup>

## Ballistic Databases

Over the last decade the BATFE has built the National Integrated Ballistic Information Network (NIBIN), a database of ballistic images from bullets and cases associated with crimes. The NIBIN is accessible to 235 forensic laboratories throughout the United States.<sup>12</sup> This system is sometimes useful to criminal investigators. For example, if a firearm is recovered from a suspected criminal's home, the NIBIN can sort through the ballistic images of bullets found at recent crime scenes in the city. If the NIBIN provides some close matches, a firearms examiner can study the crime scene bullet and the recovered gun to determine if the gun fired the bullet found at the crime scene.

FIGURE II

## Matching Success Rate of the National Integrated Ballistic Information Network Database\* (as of the 4th quarter 2002)



\* Note: This database contains images obtained from guns associated with a crime.

Source: Larry Keane, National Shooting Sports Foundation.

"Of a total of 166,672 bullet entries collected by labs, queries to the bullet image produced only 264 'hits.'"

**Matching Images.** The test begins with a cartridge case or bullet recovered from a crime scene or test fired from a gun recovered from a suspect. The image of the cartridge case and/or bullet is entered into the computer database; the computer then compares the new images to its existing image database. The database query produces a list of possible "matches," giving them a "match score" and ranking them in order of their similarity to the bullet or cartridge case at issue. According to Frederic A. Tulleners, Director of the California Bureau of Forensic Services Laboratory, because "[a]utomated computer matching systems do not provide conclusive results," the potential candidates must be "manually reviewed" by an expert ballistics examiner.<sup>13</sup>

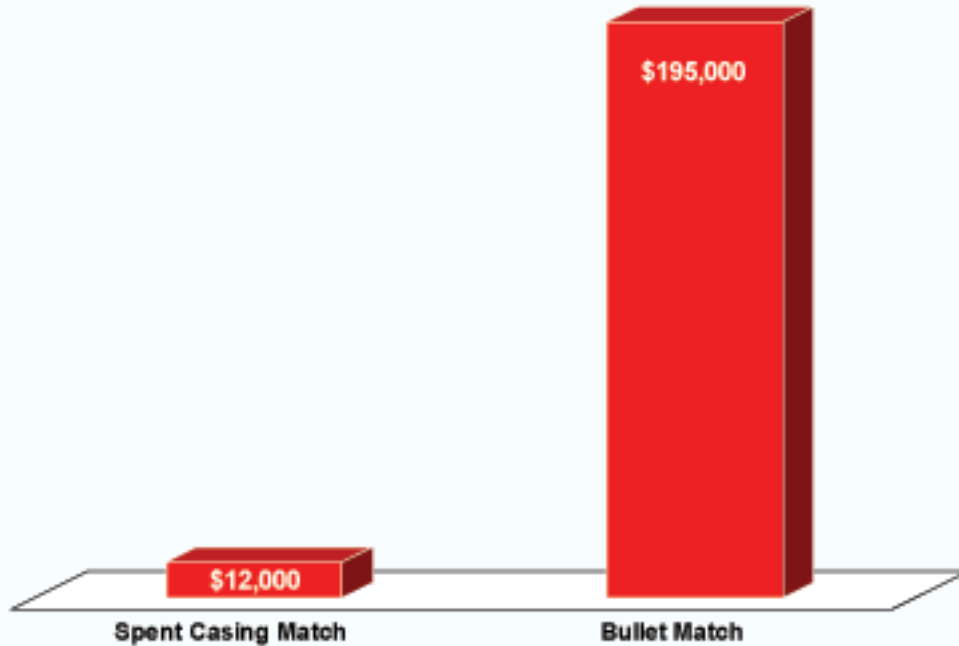
**National Database Hits.** The NIBIN Web site reports "success stories" for its automated system in suggesting preliminary matches. For the last quarter of 2002, NIBIN reported 10 cases in which NIBIN was used to provide evidence against a particular criminal or to alert investigators that a single perpetrator might have committed two or more crimes.<sup>14</sup>

Statistics about NIBIN's performance thus far were released at the November 6, 2002, meeting of the Southwest Association of Forensic Scientists in Scottsdale, Ariz., based on data supplied by 206 labs using NIBIN.<sup>15</sup> According to the statistics released:

- [ Of a total of 166,672 bullet entries collected by the labs, queries to the bullet image database had produced 264 "hits." [See Figure II.]
- [ In other words, 0.16 percent of the bullet entries were associated with a hit - a confirmed link between two different bullets or between a bullet and a gun. (No data were released on the number of hits that led to solving a crime, making an arrest or mounting a prosecution.)
- [ The NIBIN system had 351,194 cartridge case entries and had produced 4,395 cartridge case hits - a rate of 1.25 percent.

FIGURE III

## Cost of a Ballistic Imaging Match Using the NIBIN Database\*



\* Note: This database contains images obtained from guns associated with a crime.  
Source: Larry Keane, National Shooting Sports Foundation.

"It costs about \$12,000 for a cartridge case hit and about \$195,000 for a bullet hit."

**Cost of Database Matching.** These data illustrate that cartridge case ballistic identification is much more productive than bullet identification, although neither system has a very high rate of ballistic matches. The data also show that successful matches using the NIBIN system are expensive:

[ At a cost of about \$250,000 per site for equipment - not including operator training, system maintenance and operator hours - the 206 labs had spent about \$51,500,000 for equipment acquisition.

[ Thus the equipment costs alone have amounted to about \$12,000 for a cartridge case hit and about \$195,000 for a bullet hit. [See Figure III.]

The software currently used by NIBIN is the Integrated Ballistic Identification System (IBIS), manufactured by Forensic Technology, Inc., a private company. At present, IBIS is the only relevant technology available.<sup>16</sup> However, a report commissioned by the California Attorney General notes that "IBIS has not been designed for operating with large databases such as the ballistic fingerprint database."<sup>17</sup>

"Investigators with only a dozen bullets can not specify which brand or model of firearm fired them."

Police sometimes suspect that bullets found at two different crime scenes belong to a single criminal. If so, the firearms examiner can compare the bullets directly, without the NIBIN database. This is what was done in the capital-area sniper case: firearms examiners studied bullets from various murder

scenes and concluded that the bullets came from the same gun. When the killers bragged in phone calls about a robbery-murder in Alabama, bullets from an unsolved liquor store robbery in that state were microscopically compared to the Maryland-D.C.-Virginia bullets and found to match. The Maryland sniper case also highlights the limitations of ballistic imaging: investigators with only a dozen bullets were unable to specify which brand or model of firearm had fired the bullets. Indeed, the make and model of the firearm used by the snipers was unknown until the suspects were captured with the gun in their possession.

Automated preliminary ballistic imaging is especially useful when a bullet or cartridge case must be searched against a small comparison set - such as the "open case files" of unsolved crimes in a particular city. For this reason, overly large databases can actually be a hindrance, as we detail below. Currently, the NIBIN databases being created by local forensics labs contain only images of bullets or cartridge cases found at crime scenes or bullet/cartridge images created from test firing guns seized from criminals.

The current selectivity creates a high concentration of guns likely to be involved in unsolved crimes. A database that also included guns belonging to law-abiding citizens would be orders of magnitude larger and would produce many more false positives, which firearms examiners would have to spend many hours disproving.

**Incomplete Databases.** Any imaging database of new guns would be incomplete for whole classes of firearms, including shotguns and revolvers, that might be used in crimes.<sup>18</sup> The databases also would be incomplete because they would not include ballistic images for the estimated 200-million-plus guns privately owned in the United States. Costs, time constraints and privacy concerns have made retroactive gathering of ballistic data on existing guns impractical at present. Also, ballistic traces would be of very limited use if the gun matched to a crime had been sold, traded or stolen.

## Limitations of Ballistic Imaging

Ballistic imaging has obvious limitations that become more significant when we consider image databases containing all guns, or all new guns, rather than only criminal guns. Even when limited to new guns, the usefulness of an immense database as a crime fighting tool is questionable for a number of reasons.

"Wear caused by the friction of bullets traveling down a gun's barrel will change its 'signature.'"

**Identical Marks.** Initially, all guns of the same model from the same manufacturer will produce similar marks; guns produced by the very same equipment (perhaps only minutes apart) will be especially similar.<sup>19</sup> This means that even the best search algorithm will develop relatively long lists of "possible" guns that need to be test fired so the bullets and cartridge cases can be microscopically compared to the evidence.

**Worn Barrels.** Over time, wear caused by the friction of bullets traveling down a gun's barrel will change the barrel's "signature," producing different ballistic images for bullets fired when the gun was new and those fired later.<sup>20</sup>

A barrel's ballistic signature often changes much more rapidly when the barrel is new; after use, the barrel stabilizes. Sometimes the five-thousandth bullet fired through a gun will match the first; at other times, consecutively fired bullets will not match.<sup>21</sup> This is especially true for firearms that are used with high-powered magnum ammunition. Maryland and New York currently require the collection of ballistic images from new guns. The images from these guns may be significantly different from the images produced once the gun stabilizes.

Inexpensive guns, which are made from softer metals, wear more quickly. How often a gun is cleaned also affects the rate of change of the ballistic images.<sup>22</sup>

**Replacement Parts.** Replacing parts of the gun may change the ballistic image. A basic part of a gun is the receiver or frame from which the barrel, stock and other parts may be detached. Receivers have serial numbers and are generally regulated the same as complete firearms. However, many gun parts

do not have identifying serial numbers, although replacing them changes the ballistic images the firearm produces:

- [ It is common, especially among shooting sports competitors, to replace a gun's barrel, firing pin or ejector.
- [ Gun barrels, triggers, grips and other replacement parts do not have serial numbers and are not regulated the same as complete firearms.
- [ To make a comprehensive ballistic registry work, all barrels, slides, extractors and firing pins would have to be serialized and regulated as if they were complete firearms.

**Differences in Ammunition.** Ammunition of the same caliber leaves significantly different markings:

- [ Firing different ammunition from different manufacturers may vary the marks from the same gun.<sup>23</sup>
- [ Using frangible ammunition, which shatters into many small pieces on impact, also defeats ballistic identification.

**Reloaded Ammunition.** Cartridge cases often are recycled. Empty cases "reloaded" with a new bullet and gunpowder are less expensive than new ammunition. Many target shooters save money by reloading their own ammunition from kits; other shooters purchase reloaded ammunition at stores or gun shows. Reloaded ammunition often ends up being fired through a number of different firearms. In such cases, purchasers of reloaded ammunition possess cartridges with markings from many different guns; these markings then combine with the markings from the purchaser's own guns as he or she fires the reloaded ammunition. Other Ways of Altering Ballistic Images. Ballistic markings can be varied in other ways:

- [ The markings on a barrel, ejector or firing pin can be changed with a steel brush, nail file or patch soaked in an abrasive.<sup>24</sup>
  - [ The marking also can be changed by shooting ammunition with dirt, grit or grinding powder on it, or by polishing.
  - [ Even putting toothpaste on a cartridge before firing may change its ballistic image.
- "A gun's ballistic image can be altered repeatedly after crimes are committed."

**Altered Serial Numbers.** It is already common for criminals, especially black-market firearms dealers, to destroy the serial number of a gun. As ballistics databases are developed, it is likely that some criminals will change a gun's ballistic markings through one of the above methods - all of which are considerably easier and less obvious than removing a gun's serial numbers. A gun's ballistic image can be altered at leisure and altered repeatedly after crimes are committed. For example, it takes about five minutes to lightly file a gun's firing pin and breech face signature to make the cartridge unrecognizable by IBIS.<sup>25</sup> Not all alterations succeed, of course, just as not all attempts to file off a serial number completely obliterate the number.<sup>26</sup>

Once fingerprinting was invented and popularized, many criminals adapted by wearing gloves - even though gloves reduce manual dexterity and may look conspicuous. Today, some rapists wear condoms to avoid DNA identification. In Boston, where BATFE and the police have aggressively sought to match crime scene cartridge cases with guns recovered from criminals, preliminary evidence suggests that some criminals have switched from semiautomatic pistols to revolvers, which do not leave cases.<sup>27</sup>

**Examination of the King Assassination Gun.** It is true that some criminals would be too careless to conceal ballistic images, but even when no efforts at concealment are made, ballistic images can change rapidly. For example, in 1997 the family of the late Dr. Martin Luther King Jr. filed a lawsuit over what it believed to be a cover-up of the circumstances of the 1968 assassination. At the direction of a court, a select group of forensics experts fired 18 rounds through the almost-unused Remington rifle the FBI said was the murder weapon. Not only did none of the 18 bullets from the rifle match the bullet that killed Dr. King, none of the bullets matched each other. "Every test bullet was different because it was going over [copper] plating created by the previous bullet," explained a retired Connecticut police forensic examiner who served on the team.<sup>28</sup>

## Accuracy of Computer Matching



The most extensive examination so far of the accuracy of ballistic matching found that the number of possible matches in a comprehensive database would be so large as to require a substantial diversion of police resources from other, more productive crime-fighting efforts.

**The California Department of Forensic Services Study.** An October 2001 study for the California Department of Forensic Services concluded that an imaging database for new handguns would be unmanageably large:

[ When applying this technology to the concept of mass sampling of manufactured firearms, a huge inventory of potential candidates will be generated for manual review. This study indicates that this number of candidate cases will be so large as to be impractical and will likely create logistic complications so great that they cannot be effectively addressed.<sup>29</sup>

"The California Department of Forensic Services concluded that an imaging database for new handguns would be unmanageable."

Led by Frederick Tulleners,<sup>30</sup> the California researchers conducted tests to gauge the accuracy of ballistic imaging. The first test fired two rounds of Federal-brand ammunition from 792 Smith & Wesson Model 4006 .40 caliber semiautomatic pistols.<sup>31</sup> The ballistic image of one test fired cartridge case from each of the 792 guns was entered into an IBIS database. From among the second set of test fired cartridges, 50 cases were randomly selected and imaged. These images were run through the database to look for matches. A suggested match was considered a success if the IBIS computer listed the parent gun of the cartridge case in the database among the top 15 most likely guns for the leftover case.

As mentioned previously, various parts of a firearm may mark the cartridge casing and bullet, but for automated imaging only the firing pin impressions, breech face marks and ejector marks are used.

[ The computer failed to suggest any top 15 match in 38 percent of the test runs.  
[ At least one correct match was indicated for markings on cartridge cases from either the firing pin or the breech face in the remaining 62 percent of the tests.

[ In 48 percent of those tests in which IBIS suggested a correct match, the correct gun was in the top 15 suggested matches based on a distinguishing characteristic created by both the breech face and the firing pin.<sup>32</sup>

"California test had poor computer match rate with less than 800 handguns in a test database."

In other words, in this very limited test, distinguishing characteristics from more than one part of a firearm were matched and listed in the top 15 suggested matches less than one-third of the time. This is a problem because expert ballistic examiners are relatively scarce and their limited time is valuable.

Their talents are called upon only after the computer-imaging database has found a reasonable likelihood of a match - usually a top 10 match on more than one characteristic. The more matching marks, the more likely that a ballistic examiner will conduct a final comparison. In the real world, it would not be surprising to find that ballistic examiners did not as a rule even bother to inspect cartridges for comparison when a computer did not find at least two or more matching characteristics between casings.

A second test used 22 Smith & Wesson pistols, firing one shot using each of five different brands of ammunition. (The brands used were PMC-Eldorado, CORBON, ARMSCOR, Remington and Winchester.) Seventy-two of these cartridge cases were then tested against the ballistic database that had been constructed using Federal ammunition.

[ On this test, only 11 percent of the computer tests put the correct gun in the top 15 for both breech face and firing pin images.

[ Thirty-eight percent of the tests put the correct gun in the top 15 for breech face or firing pin images.<sup>33</sup>

The second test illustrated the tremendous degradation in ballistic imaging accuracy when the recovered test cartridge comes from a different manufacturer than the cartridge in the database.



The failure rate might have been even greater if the California researchers had not used looser "success" criteria than ballistic examiners actually do. Ordinarily, examiners limit their search for a ballistic match to the top 10 ranking cartridge cases.<sup>34</sup> Examiners then visually compare those 10 cases. Below the top 10, ballistic researchers generally find the odds of matching a case do not warrant the time and resources required. However, the California study counted as a "success" any ballistic identification that was ranked among the top 15 matches.<sup>35</sup> Notably, the testing was conducted on cartridge casings - since "fired cartridge casings are much easier to correlate than fired bullets."<sup>36</sup>

The California test had a dismal computer match rate with fewer than 800 handguns in its test database. The report explained that if the number of database records were a hundred thousand (one year after database implementation) or a million (after a decade), the computer matching rate would be much lower.<sup>37</sup>

In contrast to NIBIN, which focuses on crime guns, comprehensive ballistic imaging would likely produce so many "hits" it would create a database of potential "suspect" guns so large as to be useless to forensic examiners.

That markings change over time also is a problem. Even the limited success with computer matching was achieved by matching cases used in a gun at nearly the same time. The report cautioned: "Firearms that generate markings on cartridge casings can change with use and can also be readily altered by the user. They are not permanently defined identifiers like fingerprints or DNA."<sup>38</sup> And of course fingerprints and DNA are permanently associated with only one individual; consumer goods like firearms are not.

"A ballistic imaging database of all handguns would cost hundreds of millions of dollars and require an enormous number of personnel."

As the report from California details, a ballistic imaging database of all guns, or of all new handguns, would require substantial funding and an enormous number of personnel. At the federal level, the BATFE would have to receive significant increases in funding and staff to create and maintain such a database. This funding increase could come from a number of sources, none of which seems politically palatable. These include cutting the budgets of other programs and shifting the savings to the BATFE, substantially increasing taxes or fees on firearms or ammunition and dedicating the revenue to the BATFE database, or increasing deficit spending.

**BATFE's Criticism of the California Study.** A May 2002 BATFE report criticized the California study, in large part because Federal-brand ammunition was used.<sup>39</sup> BATFE argued that other ammunition would produce better results: "The bearing surface of the bullet metal and case primer could not be too hard to get good consistent detail for correlations and later visual examination, yet the ammunition components could not be too soft, as that effect would give the correlation search a different benchmark to be compared against."<sup>40</sup> In other words, BATFE argued that ballistic imaging studies should be performed under a Goldilocks standard, with test ammunition neither too hard nor too soft. However, criminal shootings rarely occur under controlled laboratory conditions.

Indeed, the Federal ammunition used in the California study is one of the three most popular brands sold in the United States and thus seems as likely as others to be used in a crime.

If the California study was flawed, the flaw was that it made matches much easier to achieve than they would be in real-world conditions. The study involved a much smaller number and variety of gun models than would be registered in an all-encompassing database. In addition, the guns used were all new, lacking the diverse histories of use and firing conditions that would have changed their ballistic images over time. Getting useful results from a real-world database containing lawfully owned guns discovered at or near crime scenes would present immense difficulties, much greater than either the California tests suggest or than would be possible under the Goldilocks standard.

A further evaluation ordered by California Attorney General Bill Lockyer found BATFE's complaints meritless and concluded that the original California study was correct.

**Peer Review of the California Study.** After the California study reported dismal prospects for ballistic imaging of noncrime guns, Attorney General Lockyer ordered an evaluation of the study by Dr. Jan De

Kinder, head of the Ballistics Section of the National Institute for Forensic Sciences in the Belgian Department of Justice. The De Kinder report was released in January 2003.<sup>41</sup> The evaluation examined the California test of 50 random cartridge cases (of a single brand) and the separate test for various brands of ammunition. De Kinder stated: "I fully agree with the analysis of the data as it was performed."<sup>42</sup>

"As the number of firearms in the database is increased, the results worsen considerably."

As De Kinder explained, "For the system to be successful, the correct gun should be listed in the top few ranks."<sup>43</sup> For the Federal ammunition, the tests had found that 38 percent of the pistols did not even achieve a place in the top 15 ranks; IBIS incorrectly predicted that at least 15 other guns were more closely matched with a particular cartridge case than was the gun from which the cartridge case was actually fired.<sup>44</sup>

The California test using a variety of ammunition brands had achieved even worse results, with 62 percent of pistols not placed in the top 15 ranks in either breech face imaging or firing pin imaging. De

Kinder commented: "[T]he trends in the obtained results show that the situation worsens as the number of firearms in the database is increased."<sup>45</sup> This is precisely why collecting ballistic images for guns not associated with crimes - such as all new guns or all new handguns - would make current ballistic imaging programs much less effective.

BATFE had criticized the California study because it used Federal cartridges, rather than Remington; BATFE claimed that Federal primers are too hard, and thus do not mark well. De Kinder explained that Federal primers are actually significantly softer than Remington's, and indeed are the softest of seven different brands of ammunition tested by Erich Randich of Lawrence Livermore National Laboratory.<sup>46</sup>

De Kinder further noted that BATFE had previously used Federal ammunition in its own protocol testing.<sup>47</sup> The manufacturer of IBIS, Forensic Technologies, Inc. (FTI), had argued that results from eight of the 50 cartridges should be ignored, since those cartridges did not match their parent gun even when carefully studied by a firearms examiner. De Kinder replied: "FTI proposed to remove them from the statistics to achieve better results. This is unacceptable...all data points have to be taken into consideration."<sup>48</sup>

De Kinder's agreement with the California study was conclusive: "As progressively larger numbers of similarly produced firearms are entered into the database, images with similar signatures should be expected that would make it more difficult to find a link. Therefore, this increase in database size does not necessarily translate to more hits."<sup>49</sup>

In other words, collecting ballistic images from guns not involved in crime (such as all new guns) would degrade existing ballistic imaging forensic efforts. The existing city-based databases of crime-related ballistic images would be flooded with orders of magnitude more images from ordinary firearms sales.

This flood of additional data would seriously impair the ability of the NIBIN to produce "cold hits" linking a bullet or cartridge case to a gun owned by a criminal who was not a suspect in the crime where the bullet or cartridge case was found.

**Maryland and New York Databases.** The problems caused by creating databases of guns owned by law-abiding citizens are illustrated by the experience of Maryland and New York.

A 2000 Maryland law requires that images of test fired cartridge cases for every new handgun sold be added to the state's ballistic database. Gun buyers are charged \$20 per gun for this system, and the state government has so far spent \$5 million on it. The database now includes images from over 17,000 guns. The program has been used 155 times by investigators and has not solved a single violent crime - even though the database comprises new handguns, which are more likely to be used in a crime than are older handguns, rifles or shotguns. The database did help identify two stolen handguns.<sup>50</sup>

The Maryland State Police spent \$1.1 million to purchase the Integrated Ballistic Identification System (IBIS) software to run its database. The \$1 million that paid for IBIS was cut from community-policing funds.

"Maryland's ballistic database has images from over 17,000 guns and has been used 155 times by investigators, but has not solved a single violent crime."

The warranty on IBIS costs \$150,000 per year. Seventeen people have been hired to administer the system at an annual cost of about \$643,000, while annual operating costs are about \$112,000. Meanwhile, the Maryland government cut 12 state trooper positions as an economy measure. Had the money spent on "ballistic fingerprinting" been used to maintain the existing community police programs or to maintain state police levels, many more crimes might have been solved or prevented. Even one solved crime would outweigh the nonexistent crime-solving accomplishments of the "ballistic fingerprinting" program.

The Maryland law has been quite effective in suppressing firearms sales. For example, the Thompson/Center Encore is a custom pistol for which the buyer can choose from a variety of calibers and barrels. The gun is shipped to the dealer without a barrel, so the gun cannot be test-fired at the factory and therefore cannot be sold in Maryland - even though this high-quality single-shot pistol costs over \$500 and is virtually never used in crimes.

New York initiated its own statewide ballistic database program for law-abiding gun owners in March 2001 for a startup price of \$4.5 million. Thus far, not a single case has been prosecuted in New York as a result.<sup>51</sup> As of November 2002, the system had yet to produce a single hit.<sup>52</sup>

## Conclusion

As a rule, police support and lobby for any cost-effective tool that might improve their odds of solving or preventing crimes. Based on the current state of the technology, the Fraternal Order of Police (FOP), the largest police organization in the United States, stated that two questions must be answered before substantial resources are devoted to the creation of a ballistic database.<sup>53</sup>

- [ First, since ballistic imprints, unlike fingerprints and DNA, can be altered, either deliberately or through normal use, how would the validity of the findings be ensured?
- [ Second, how would such a database be compiled and what would be the cost to create and maintain it?

The organization's statement declared:

FOP does not support any federal requirement to register privately owned firearms with the government. Without federally mandated registration of the more than 200 million firearms in the U.S. today, such a database would be no more effective than the current NIBIN maintained by BATFE. And even if such a database is limited to firearms manufactured in the future, the cost to create and maintain such a system, with such small chances it would be used to solve a firearms crime, suggests to FOP these are law enforcement dollars best spent elsewhere.

"Ballistic imaging technology cannot come remotely close to fulfilling the promises that gun control advocates make."

Ballistic imaging technology cannot come remotely close to fulfilling the promises that gun control advocates make. To require ballistic registration of all new guns would most likely waste massive law enforcement resources. A company named NanoVia says it is developing what may one day be a realistic alternative: a micro device that stamps a tiny imprint of the gun's serial number onto every cartridge case.<sup>54</sup> Such a device might one day be a useful forensic tool. For now, ballistic imaging mandates for noncrime guns would only hinder effective law enforcement.

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NOTE: Nothing written here should be construed as necessarily reflecting the views of the National Center for Policy Analysis or as an attempt to aid or hinder the passage of any bill before Congress.

Notes

Frederic A. Tulleners, Laboratory Director, Bureau of Forensic Services, California Dept. of Justice, Technical Evaluation: Feasibility of a Ballistics Imaging Database for All New Handgun Sales (Oct. 5, 2001), pages 2-2 to 2-3, [http://www.nssf.org/PDF/Technical percent20Evaluation.pdf](http://www.nssf.org/PDF/Technical%20Evaluation.pdf).

Tulleners, page 2-4.

Tulleners, pages 2-2 to 2-3 and 3-1 to 3-2. For automated imaging, only the firing pin impressions, breech face marks, and ejector marks are used. Tulleners, page 3-2.

Some bolt-action rifles do show ejector markings. Shotgun shells, like .22 cartridge cases, are often of very little value for ballistic identification. Tulleners, page 2-4. See also Jan De Kinder, Review AB1717 Report. Technical Evaluation: Feasibility of a Ballistics Imaging Database of All New Handgun Sales, page 17, [www.nssf.org/PDF/DeKinder.pdf](http://www.nssf.org/PDF/DeKinder.pdf): "Shotgun shells do not carry many marks..."

De Kinder, page 17.

Tulleners, pages 2-4, 6-3; De Kinder, page 17.

De Kinder, page 17.

Peter Weiss, "A Shot in the Light," Science News, Jan. 11, 2003.

Tulleners, page 5-2.

The Glock has a quite distinctive breech face and other marks. Tulleners, pages 3-3 to 3-4. A test conducted by FTI, the manufacturer of IBIS, reported a correlation rate of 83 percent to 85 percent for Glock 9mm pistols - far higher than the 38 percent to 62 percent correlation for Smith & Wesson pistols in the California study discussed below. De Kinder, page 14. Real-world evaluation of ballistic imaging must take into account the fact that there are many varieties of handguns other than Glocks. Although it is debatable how accurately BATFE gun traces reflect actual patterns of criminal gun use, it should be noted that a BATFE 2000 report found Smith & Wesson guns in the top 10 of nearly every major category of handgun trace requests, while Glock pistols never appeared in the top 10 in any category.

Department of the Treasury, Bureau of Alcohol, Tobacco and Firearms, Crime Gun Trace Reports (2000), pages 13-22, Tables 5-6, 8. On page 18 of the same report, BATFE did state that Glocks were "frequently recovered" in some cities, albeit not often enough to put Glock in the top 10 for juveniles, youths or adults from whom guns were seized,

Tulleners, pages 1-1 and 2-4. Bullets from .22 handguns are especially difficult to identify. Being small, .22 bullets deform more when they strike a target.

NIBIN Web site, [www.nibin.gov](http://www.nibin.gov).

Tulleners, page 1-1.

"Success Stories," [http://www.nibin.gov/nb\\_success.htm](http://www.nibin.gov/nb_success.htm).

The authors thank Larry Keane of the National Shooting Sports Foundation for bringing this data to our attention.

De Kinder, page 12.

De Kinder, page 12, citing Tulleners.

Revolvers don't typically leave shell casings at the scene. The shells remain in the cylinder, to be replaced manually when the shooter chooses.

For some inexpensive guns, the stamped breech faces produce identical ballistic images, so that a bullet from one gun may be mistakenly identified with a different gun, even by an expert examiner. Tulleners, page 3-4 to 3-5. These inexpensive guns are especially likely to produce false hits when included in an automated system. Tulleners, page 3-5.

Trained firearms examiners can usually confirm a match between a gun's early ballistic signature and a later ballistic signature. This does not mean that a computer-matching program can succeed in matching a late-fired bullet to a database image from the gun's youth. Tulleners, page 1-1.

Tulleners, page 2-4.

Also, dirt and lead buildup can partially obscure the breech face impression. Tulleners, pages 3-2 - 3-3.

Tulleners, page 1-2. The BATFE disputes this point, arguing that the marks do not change, although they may be shallower or deeper on different brands. The evaluator commissioned by the California Attorney General explained: "Both opinions can be easily brought together by noting that as the depth of mark decreases, it will be invisible even for microscopic observations." De Kinder, page 11.

Tulleners, Appendix F, reprinting Bill Twist, "Erasing Ballistic Fingerprints," PlanetTimes.com (downloaded Aug. 10, 2000).

Tulleners, pages 1-5, 8-9 to 8-10.

De Kinder reported that about 10 percent of the guns examined by his laboratory in Belgium had erased serial numbers and estimated that the rate of ballistic image alteration would be about the same. He added: "Whereas the BATFE sees altering a firearm as a non-issue, it is a real problem: Any reduction in the proportion of 'hits' caused by such an alteration to a firearm is of concern when evaluating the usefulness from a technical point of view of a 'gun sales database.'" De Kinder, page 17.

Anthony A. Braga, Harvard University, "Reducing Gun Violence in Boston: Intervening in Illegal Markets," presentation to the annual meeting of the Academy of Criminal Justice Sciences, Anaheim, Calif., Mar. 8, 2002. As criminal awareness of ballistic imaging grows, some criminals may attach "brass catchers" to their semiautomatics. (Brass catchers are inexpensive nets which catch the cartridge case being ejected from a semi-automatic.) Criminals might also retrieve cartridge cases belonging to innocent people (hundreds or thousands of empty cases can be found at shooting ranges) and drop them at a crime scene. Soft lead bullets (as opposed to lead bullets with copper jackets) are more likely to deform greatly on impact, reducing or eliminating their forensic utility. Sophisticated criminals could use ammunition with old-fashioned black powder, which burns much dirtier than modern smokeless powder and would obliterate most of a ballistic image. Tulleners, Appendix F.

Gail Gibson and Dennis O'Brien, "Ballistic 'fingerprint' database isn't foolproof tool, experts say. System unable to account for stolen firearms, wear," Baltimore Sun, October 15, 2002.

Tulleners, p. 1-1.

Other participants included firearms examiners from the Los Angeles Police Department, Orange County Sheriff's Department, Oakland Police Department and the Sacramento County District Attorney's Office.

Tulleners, page 1-3. De Kinder estimated that an actual California database would include at least 3,300 guns of this model. De Kinder, page 8.

Tulleners, pages 1-4, 7-2 and 8-1 to 8-4.

Tulleners, pages 1-4, 7-3 and 8-7 to 8-9.

Tulleners, page 1-5.

Tulleners, page 8-12.

Tulleners, page 1-2.

Tulleners, pages 1-2 to 1-3.

Tulleners, page 1-2 and page 6-2.

Robert M. Thompson, Jerry Miller, Martin G. Ols and Jennifer C. Budden, National Integrated Ballistics Information Network; Bureau of Alcohol, Tobacco and Firearms, U.S. Dept. of the Treasury, Ballistic Imaging and Comparison of Crime Gun Evidence by the Bureau of Alcohol, Tobacco and Firearms (May 13, 2002).

Thompson et al., page 15.

De Kinder, Review AB1717 Report. Technical Evaluation: Feasibility of a Ballistics Imaging Database of All New Handgun Sales.

De Kinder, pages 14 and 15.

De Kinder, page 3.

De Kinder, page 3.

De Kinder, page 3.

De Kinder, pages 3-4, 8-12. The Federal primer had a hardness (measured on the Vickers Hardness scale) of 108. Other brands measured 157 (Remington), 114, 159, 186, and 166, De Kinder, page 9. Details about the Vickers Hardness measurement standard can be found at the Web site of the United Kingdom's National Physical Laboratory, <http://www.npl.co.uk/force/guidance/hardness/vickers.html>. De Kinder explained that other factors besides primer hardness also affect how well a cartridge case will accept breech face markings. These factors include primer seating and buildup of gas pressure.

Overall, a 1997 test by the Forensic Institute in the Netherlands showed Federal cartridges to be medium in their acceptance of breech face markings. De Kinder, page 10. Federal cartridges accept distinctive breech face marks and firing pin marks far better than do Remington cartridges. De Kinder, page 11.

De Kinder, page 9, note 6.

De Kinder, pages 4 and 14.

De Kinder, page 12; Tulleners, page 1-2.

John Lott, "Bullets and Bunkum," National Review, Nov. 11, 2002, page 30.

The Maryland and New York programs use the IBIS software program, but they are not part of the BATFE's NIBIN database for crime guns, since federal law requires that NIBIN compile only images for crime guns. Thompson et al., page 4. (Of course Maryland and New York police can still use the NIBIN database.) Even without the express limitation for NIBIN, the federal statute forbidding the compilation of federal registration of (law-abiding) gun owners may, arguably, make it illegal for the Maryland and New York databases to be integrated into NIBIN. 18 U.S. Code sect. 922(t)(2)(C).

Leslie Koren, "Matching a Firearm to a Crime," The Record (Bergen County, N.J.), Nov. 4, 2002.

Grand Lodge, Fraternal Order of Police, F.O. PAGE Viewpoint: Ballistics Imaging and Comparison Technology (Washington: 2002), [www.tsra.com/FOP.htm](http://www.tsra.com/FOP.htm).

"New Device May Offer Alternative to Ballistic Imaging," The Firearms & Outdoor Trade, Dec. 1, 2002, page 4.