



JUNE 2013

NATIONAL INSTITUTE OF JUSTICE
RESEARCH
REPORT

**A Review of
Gun Safety
Technologies**

BY MARK GREENE, Ph.D.

NIJ

**U.S. Department of Justice
Office of Justice Programs
810 Seventh St. N.W.
Washington, DC 20531**

Eric H. Holder, Jr.
Attorney General

Karol V. Mason
Assistant Attorney General

Greg Ridgeway
Acting Director, National Institute of Justice

This and other publications and products
of the National Institute of Justice can be
found at:

National Institute of Justice
<http://www.nij.gov>

Office of Justice Programs
Innovation • Partnerships • Safer Neighborhoods
<http://www.ojp.usdoj.gov>

JUNE 2013

NATIONAL INSTITUTE OF JUSTICE

RESEARCH REPORT

A Review of Gun Safety Technologies

BY MARK GREENE, Ph.D.

NIJ

Highlights

- Since the mid-1990s, numerous teams have developed firearms with advanced gun safety technology—often called “smart guns” or “personalized firearms”—to varying degrees of technological maturity.
- These firearms are designed to contain authorization systems which generally combine an authentication mechanism that actuates a blocking mechanism in a seamless process that is designed to take less time than handling and firing a conventional gun.
- At least three products—two handguns and a shotgun—have been developed in the private sector by Armatix GmbH, Kodiak Industries, and iGun Technology Corporation that could at least be described as *commercializable* or *pre-production*.
- There are no personalized firearms available commercially in the United States yet today, but Armatix and Kodiak are planning to bring their respective products to market in 2013.
- Armatix of Germany has developed the Smart System which is composed of a .22 caliber pistol called the iP1 that is activated by the iW1, a device worn on the wrist like a watch that communicates using radio frequency identification (RFID).
- Armatix reports that it has sold the Smart System in Europe and Asia and is pursuing approval for commercial sale in the United States through its U.S. subsidiary Armatix USA.
- Kodiak Industries of Utah recently launched the Intelligun, a fingerprint-based locking system installed on a model 1911-style .45 caliber pistol that is available for pre-order from Kodiak with a projected delivery date later in 2013.
- The Intelligun system will add an equivalent weight of less than one round to the total weight of the firearm and is reported to have an expected failure rate of 1 in 10,000, which is reported to be less than the expected failure rate of the firearm it is installed on.

- iGun Technology Corporation of Florida developed in 1998 the M-2000, a shotgun that could be considered the first personalized firearm where the user wears a ring with a passive RFID tag embedded that communicates with an RFID reader onboard the firearm.
- iGun performed a number of tests and determined that the unit was reliable and estimates that enough components were created in 1998 to assemble 50 working units, but the project was shelved due to market research showing limited consumer demand.
- The reliability of smart guns remains a topic of interest since early efforts at development in the mid-1990s, with *reliability* indicated as the most important concern by law enforcement practitioners regarding the potential use of this technology in a report published in 1996 that was funded by the National Institute of Justice.
- Reliability can be defined as the probability that a device will perform its intended function for a specified period of time under stated conditions.
- Test protocols already promulgated by U.S. Government agencies and other standards organizations, or protocols that could be developed, could be used to test engineered firearm systems under different operating conditions to provide quantitative metrics on reliability.

Table of Contents

About the Report	7
Developing the Report	9
Acknowledgments	12
Executive Summary	13
A Perspective on Risk, Reliability, and Person-centric Technologies	19
Technologies for User Authorization	24
Token-Based Technologies	24
Biometric Technologies	26
Technology Readiness Levels	27
Technology Quick Reference Tables	29
Upper Tier	29
Middle Tier	30
Lower Tier	33
Technology Developers	34
Sandia National Laboratories	34
Colt's Manufacturing Company, Inc.	36
iGun Technology Corporation	39
Smith & Wesson	43
FN Manufacturing, Inc.	45
New Jersey Institute of Technology	50
Metal Storm	54
University of Twente	57
Armatix GmbH	57
Safe Gun Technology	65
TriggerSmart	67
Kodiak Industries	69
Biomac Systems, Inc.	75
Online Resources	77
Glossary of Acronyms Used	79
References	82

A Review of Gun Safety Technologies

BY MARK GREENE, Ph.D.

About the Report

When such an issue with deep and powerful cultural resonance as firearms is given the full attention of the nation, the challenges involved with confronting the complex interconnectedness of law, public safety, Constitutional rights, policy, technology, market forces, and other concerns seem only amplified. With careful consideration, however, untangling the various components of the issue is possible, and an investigation of technology can be accomplished with minimal diversion into the other realms.

This report examines existing and emerging gun safety technologies and their availability and use to provide a comprehensive perspective on firearms with integrated advanced safety technologies. These firearms are known by various terms such as smart guns, user-authorized handguns, childproof guns, and personalized firearms. A “personalized firearm” can be understood to utilize integrated components that exclusively permit an *authorized user* or set of users to operate or fire the gun and automatically *deactivate* it under a set of specific circumstances, reducing the chances of accidental or purposeful use by an *unauthorized user*.

A report published in 2005 entitled *Technological Options for User-Authorized Handguns: A Technology-Readiness Assessment* discussed this in the context of two defined types of handgun owner: (1) people responsible for public safety (i.e., law-enforcement personnel) and (2) people concerned with personal safety and handgun misuse, particularly by children, in the home (i.e., homeowners).¹ The National Academy of Engineering (NAE) Committee on User-Authorized Handguns published this report seeking to clarify the technical challenges of developing a reliable user-authorized handgun (UAHG) to reduce certain types of handgun misuse.

The goal of this work is to provide an objective, neutral perspective on existing and emerging gun safety technologies and their availability and use today. In assessing what technologies and products exist or may exist in the near future, it is important to clarify what the technologies can and cannot do, to distinguish the difference between fact and fiction, and to manage expectations about how these firearms could reasonably be expected to perform. The material presented here should be considered in a sober manner with the understanding that the use or misuse of any firearm regardless of what technology may or may not be integrated could lead to injury or death.

Any information presented here shall not be construed to be an endorsement of any particular technology, developer, patent, company, or approach. Furthermore, any information that may not be included here shall not be construed as disapproval. Finally, given the various perspectives and opinions on firearms, any topic discussed here with a nexus to technology that may also overlap with another dimension of the greater national conversation about firearms shall not be construed to be a substantive discussion of the topic outside of the technologically focused perspective presented here.

Developing the Report

The National Institute of Justice (NIJ) was tasked with supporting the President's Plan to Reduce Gun Violence,² specifically:

"The President is directing the Attorney General to work with technology experts to review existing and emerging gun safety technologies, and to issue a report on the availability and use of those technologies."

In support of this Executive action, NIJ has conducted a technology assessment and market survey of existing and emerging gun safety technologies that would be of interest to the law enforcement and criminal justice communities and others with an interest in gun safety. This assessment builds on previous technology reviews on this topic area produced by Sandia National Laboratories in 1996³ and 2001⁴ and the National Academy of Engineering in 2003⁵ and 2005.⁶ The assessment examines *smart or personalized* technologies implemented into firearms that prevent anyone other than an authorized user from firing it. Example gun safety technologies include proximity devices, such as radio frequency identification (RFID) chips and magnetic rings, and biometric devices, such as fingerprint scanners. The assessment also examines firearms that employ electronic or software components integrated into safety mechanisms. The report summarizes past and present research and development (R&D) and product development efforts in industry, academia, and government. It includes a technical assessment of each development effort and contains an estimation of technology maturity for each effort reviewed.

The assessment was led by a General Engineer in the Office of Science and Technology at NIJ with assistance from technical staff at the Sensor, Surveillance, and Biometric Technologies Center of Excellence (hereafter cited in the text as the "SSBT Center"). The SSBT Center is operated by ManTech International Corporation under NIJ award 2010-IJ-CX-K024 and is a Center within the National Law Enforcement and Corrections Technology Center (NLECTC) System funded by NIJ. The SSBT Center

provides scientific and technical support to NIJ's sensor, surveillance, and biometrics R&D efforts as well as technology assistance, information, and support to criminal justice agencies. The primary role of the Centers of Excellence is to support NIJ's research programs in different technical areas and to assist in the transition of law enforcement technology from the laboratory into practice by first adopters. They assist NIJ in identifying the technology needs of the criminal justice community and conduct related research, test, and evaluation activities. The Centers of Excellence are the authoritative resource within the NLECTC System for both practitioners and developers in their technology area(s) of focus.

To assist with information gathering of technology and technology-related issues to inform this report, NIJ organized a workshop on gun safety technologies in March 2013. Representatives from a majority of the entities covered in this report were present to have the opportunity to discuss their technology, R&D efforts, product development, and technology-related issues. Relevant staff from the Department of Justice, Department of Homeland Security, Department of Defense, and the Office of Science and Technology Policy attended as well as participants from several outside organizations including firearms manufacturers, the Sporting Arms and Ammunition Manufacturers' Institute (SAAMI), and the Johns Hopkins Center for Gun Policy and Research. Discussion topics included modern history of gun safety technology and early R&D in smart guns (ca. 1994–2006); existing and emerging gun safety technology and smart guns today (ca. 2006–present); availability and use of gun safety technology and smart guns today, including a broad discussion of potential users and user requirements; technological barriers to developing reliable and effective technologies and products; and market barriers to introducing reliable and effective technologies and products.

In support of research activities, NIJ and the SSBT Center pursued several sources of information from February to May 2013: site visits, face-to-face meetings, telephone interviews, technology demonstrations, email correspondence, literature review, online investigations, NIJ archival documents, and Bureau of Justice Assistance (BJA) archival documents.

SSBT Center staff visited the following organizations in March and April of 2013:

- Kodiak Industries
- iGun Technology Corporation
- New Jersey Institute of Technology
- University of Massachusetts Lowell
- Safe Gun Technology
- Armatix GmbH
- TriggerSmart

The following organizations declined individual interviews or meetings for this report, which may not have been due to a lack of interest but rather a lack of an ongoing program in this topic area. However, they were responsive to email correspondence and telephone calls:

- Colt Defense
- Colt's Manufacturing Company LLC
- FN Manufacturing
- FN USA
- Metal Storm
- Smith & Wesson
- Sturm, Ruger & Co.

Each entity listed in the Technology Developers section, except for Sandia National Laboratories, was afforded the opportunity to review a draft version of the following report content: the Technology Readiness Levels section, the general portion of the Technology Quick Reference Tables section, their specific table, the brief general portion of the Technology Developers section, and their specific subsection from the Technology Developers section. The content on Sandia National Laboratories is drawn from published reports that are publicly available, so no further review from Sandia was sought in that particular case. The report as a whole was reviewed by personnel at the Department of Justice, Department of Homeland Security, and Department of Defense with knowledge or experience with firearm technology or smart gun R&D.

NIJ also released a Federal Register notice on February 20, 2013, to alert the public that NIJ was conducting this review.⁷ This public notice encouraged stakeholders to self-identify and provided accessible means to relay relevant information and comments to NIJ through an online resource hosted on the NLECTC website (www.justnet.org) or a dedicated email address established for this effort (gunsafetytechnology@usdoj.gov). No comments were received from the public that were found to be responsive to the needs of the report.

The assessment did *not* include any research into legislature, social, or community policy or politics; did *not* cover integration of gun safety technologies into law enforcement procedures in the field (e.g., police patrol duties); and did *not* include physical testing of identified devices or products. However, the report will discuss documented critical requirements of the gun owner or user in order to properly enable smart gun technology.^{8,9} The objective of the assessment is ultimately to provide an unbiased summary of existing and emerging technologies and the availability and use of those technologies to inform any future Federal R&D strategy and innovation in gun safety technology across the community of practice and technology ecosystem.

Acknowledgments

The National Institute of Justice would like to acknowledge personnel from the following organizations for providing information regarding their technology, products, intellectual property, and other activities related to gun safety technology (in alphabetical order): Armatix GmbH, Armatix USA, Biomac Systems, iGun Technology Corporation, Kodiak Industries, New Jersey Institute of Technology, Safe Gun Technology, TriggerSmart, and the University of Twente. NIJ would like to thank personnel at the NLECTC National Center for photographs of the Sandia demonstrators and one of the Colt prototypes. NIJ would also like to acknowledge personnel from the Firearms Technology Branch, Bureau of Alcohol, Tobacco, Firearms and Explosives; the Department of Homeland Security, Science and Technology Directorate; and the U.S. Army Armament Research, Development and Engineering Center for reviewing the draft manuscript of this report.

Executive Summary

Since the mid-1990s, numerous teams were found to have developed firearms with advanced gun safety technology to varying degrees of maturity. These firearms, often called smart guns or personalized firearms, are designed to contain authorization systems which generally combine an authentication mechanism that actuates a blocking mechanism in a seamless process that is designed to take less time than handling and firing a conventional gun. At least three products—two handguns and a shotgun—have been developed by innovators in the private sector that are at a technological maturity level that could at least be described as *commercializable* or *pre-production*. The innovators are Armatix GmbH, Kodiak Industries, and iGun Technology Corporation. There are no personalized firearms available commercially in the United States yet today, but Armatix and Kodiak are planning to bring their respective products to market in 2013.

Armatix of Germany has developed the Smart System which is composed of two main parts, the iP1 and the iW1. The iP1 is a .22 caliber pistol that is activated by the iW1, a device worn on the wrist like a watch that communicates using radio frequency identification. Armatix reports that it has sold the Smart System in Europe and Asia and is pursuing approval for commercial sale in the United States through its U.S. subsidiary Armatix USA. It has submitted the Smart System for testing in laboratories for certification by relevant Federal and state authorities and organizations.

Kodiak Industries of Utah developed the Intelligun, a fingerprint-based locking system installed on a model 1911-style .45 caliber pistol to unlock the firearm for operation immediately for authorized users. The Intelligun system will add an equivalent weight of less than one round to the total weight of the firearm and is reported to have an expected failure rate of 1 in 10,000, which is reported to be less than the expected failure rate of the firearm it is installed on. Kodiak launched the Intelligun in 2012 and debuted it in 2013 at a widely attended annual firearms

trade show. A 1911-style pistol with the Intelligun system installed is available for pre-order from Kodiak with a projected delivery date later in 2013.

iGun Technology Corporation of Florida developed in 1998 the M-2000, a shotgun that could be considered the first personalized firearm to go beyond a prototype to an actual commercializable or production-ready product. The M-2000 operator wears a ring with a passive RFID tag embedded that transmits a specific code when energized by the RFID reader onboard the shotgun. iGun performed a number of tests and determined that the unit was reliable. iGun shelved the project due to market research showing limited consumer demand but estimates that enough components were created in 1998 to assemble 50 working units.

NIJ funded over \$11.1M in research and development projects over more than a decade from the mid-1990s through the mid-2000s to investigate different technologies and develop functional prototypes of handguns with electronic safety mechanisms built in that would prevent anyone other than an authorized user from firing it. NIJ supported requirements gathering and technology reviews in this topic area, which were published by Sandia National Laboratories in 1996¹⁰ and 2001.¹¹ Various scenarios such as law enforcement firearms being seized in the field and used against officers, accident prevention in the home, child safety, and preventing the use of stolen firearms in criminal activities were considered as possible use cases where smart guns could have an impact. In addition, from 2008 to the present, the Bureau of Justice Assistance has also provided just over \$1.5M to fund a project begun through NIJ. NIJ also participated in workshop and review efforts by the National Academy of Engineering in 2003¹² and 2005.¹³

In total, the Office of Justice Programs (OJP) has supported at least \$12.6M in gun safety technology research over the past fifteen years that has catalyzed the development of some early experimental designs that have incorporated a range of technologies that have helped build a foundation upon which subsequent efforts have followed. The history

of research and development in smart guns has shown this to be a challenging technology area, and a number of well-known names from the firearms industry have pursued serious efforts to produce functional prototypes over the years. While none were successful enough with their designs to bring models to the marketplace, the initial R&D has provided a wealth of knowledge and experience on which to build.

In 1997, NIJ awarded \$500,079 to Colt's Manufacturing Company, Inc. of Hartford, CT, to develop a smart gun based on an earlier design it developed independently based on radio frequency communication. The Colt device had a wristband that communicated with the firearm which enabled a mechanical actuator in the handgun when in close proximity. In March 2000, two prototypes demonstrated that it was possible to integrate its concept into a handgun; however, the prototypes proved unreliable and not ruggedized enough to permit serious test firing, so reliability evaluations could not be conducted. Although Colt evidently also funded R&D internally to move its technology forward, it curtailed further efforts in this area around this time.

Between 2000 and 2005, NIJ provided \$3,673,361 to Smith & Wesson of Springfield, MA, to develop a handgun that could only be used by an authorized user. Smith & Wesson explored different methods of authentication including PIN codes, biometric fingerprints, and skin tissue spectroscopy approaches. Prior to the cooperative agreements with NIJ, Smith & Wesson reported it had internally funded a grip sensor that was incorporated in the handle of the handgun. Although Smith & Wesson proposed a goal of delivering 50 prototypes for test and evaluation, reliably integrating the electronics into the firearm proved to be a challenge and ultimately only two demonstration items were delivered.

Between 2000 and 2006, NIJ provided \$2,606,156 to FN Manufacturing, Inc., of Columbia, SC, a subsidiary of FN Herstal, to develop an RFID-enabled handgun called the Secure Weapon System (SWS). FN provided a comprehensive technical report on the SWS and a designed, developed, and integrated prototype that represented the combination of selected

Thank You for previewing this eBook

You can read the full version of this eBook in different formats:

- HTML (Free /Available to everyone)
- PDF / TXT (Available to V.I.P. members. Free Standard members can access up to 5 PDF/TXT eBooks per month each month)
- Epub & Mobipocket (Exclusive to V.I.P. members)

To download this full book, simply select the format you desire below

