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Firearms Training Technologies for Accuracy and Qualification

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The Homeland Defense & Security Information Analysis Center (HDIAC) is a DoD IAC sponsored by DTIC to provide expertise in eight technical focus areas: alternative energy; biometrics; chemical, biological, radiological, & nuclear (CBRN) defense; critical infrastructure protection; cultural studies; homeland defense & security; medical; and weapons of mass destruction. HDIAC is operated by SURVICE Engineering Company under contract FA8075-21-D-0001.

A chief service of the DoD IACs is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry jointly conducted by HDIAC.

Abstract

Providing U.S. government training staff with powerful tools to efficiently analyze interpretable data and synthesize training solutions could be a bonus for firearm training programs across the nation. The Homeland Defense and Security Information Analysis Center investigated what research, hardware, and software are available to address technology gaps found in modern firearms training programs and augment the skillset of trainer and trainee.

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1.0 TI Request

1.1 Inquiry

The Homeland Defense & Security Information Analysis Center (HDIAC) was asked what firearms training software/hardware is available to train and improve federal/U.S. Department of Defense (DoD) employees in firearm accuracy and to identify technology gaps found in modern firearms training programs and augment the skillset of trainer and trainee. The primary focus was on handguns/pistols and shooter analysis.

1.2 Description

The end user for this request is an instructor for a federal agency who is looking to provide the students at their program with two main solutions:

1. Additional support for less proficient trainees.
2. A more autonomous training period when the instructor engages other trainees.

These solutions should also record training data for future classes.

2.0 TI Response

HDIAC initially reached out to its subject matter expert network for agencies using various training platforms relevant to this request. An open-source survey of commercially available platforms was performed, and other search tools like the Defense Technical Information Center's Research and Engineering Gateway were used to gather a response that was as complete as possible. The results of the community outreach and platform searches are summarized and broken down into the following three categories:

1. Hardware and software solutions
2. Virtual reality (VR) and simulation platforms
3. Other solutions

3.0 Hardware and Software Solutions

There were many potential solutions available or almost ready for commercial and government use. The different hardware and software solutions that were discovered are listed next.

3.1 Mantis Tech

Mantis Tech developed an attachment to a firearm that analyzes the techniques and results of shooters using the onboard hardware to the attachment. This feeds data to a software application on a mobile device, such as a phone or tablet, for review and provides recommendations to the end user in real-time [1, 2]. The application can provide a training program and target specific challenges based on the user's difficulties with the application.

3.2 LaserHIT

LaserHIT offers a platform that uses its laser cartridges paired with its dry fire training kit to provide a training solution that does not require live fire to practice fundamentals. They advertise 300,000 hits or a three-year duration on a single laser cartridge that does not generate a ballistic object. This greatly reduces the cost of weapons maintenance and allows additional time to train with firearms instead of devoting time to cleaning [3].

3.3 Blowback Laser Trainer

Blowback Laser Trainer System developed a laser-based training system that includes a target that can be hung indoors, as well as a laser-based weapons system that uses a realistic weight paired with carbon dioxide (CO₂) cartridges to emulate a realistic training experience. This system is more affordable than current methods and does not use live fire ballistics, giving it the same perks as other nonballistic training tools [4].

3.4 TrainingSights

TrainingSights developed a series of different training aids to overlay onto a target. A user can align a scope overlay to a target, demonstrate an ideal sight picture for iron sights, give training on proper sight alignment, or just highlight a specific region. The company's products are inexpensive and have designs for pistols, rifles, or various sight pictures for specific scopes [5].

3.5 Strikeman

Strikeman developed a laser firearm training system that is intended to be used indoors with laser cartridges inserted into specific firearm models. Purchasing a laser cartridge, Strikeman Target, and smartphone holder and downloading the application for the full training tools are inexpensive [6].

3.6 GreenAmmo

Green Ammo developed a training system that involves using a drop-in bolt, rounds, and a buttstock for rifles to allow a realistic training experience that utilizes electronic “blank” rounds to mitigate wear and tear on a rifle and the impacts of consumable, conventional ammunitions. Each “E-blank” magazine will give roughly 150,000 shots before needing to be replaced [7, 8].

3.7 Marathon

Although technically outside the scope of this inquiry, as Marathon’s platform is intended to provide nonmarksmanship training scenarios for a proficient individual or team already familiar with firearms and their use, the company’s technology and approach are certainly worth mentioning for follow-on training scenarios. Marathon creates autonomous robots that can be used to instill confidence in a shooter/team for live-fire simulations against mobile robots who can act similarly to how humans would when engaged [9]. Shot groups can be analyzed and most likely be used in conjunction with some of the other technologies on this list to provide real-time analytic data on autonomous, mobile targets.

3.8 Synthetic Weapon Technologies

Synthetic Weapon Technologies has developed a laser-based weapons training tool that utilizes a projector and high-fidelity “hit detection sensors” to emulate a range-style environment. The goal is to pair the projector with their mimetic weapons models to provide as realistic and convenient an indoor training environment as possible without the need for ballistics or live weapons and ammunition [10].

3.9 Phoenix Defense LLC

Phoenix Defense LLC utilized a combination of government off-the-shelf technology and developed systems to provide a product capable of real-time feedback during training. It can be used at any live range, firing line, or other desired location. This approach utilizes an acoustic detection system to monitor, track, and record where rounds travel and impact, even if there is no contact made with a target [11].

3.10 G-Sight

G-Sight developed a combination of self-developed applications, a laser cartridge insert that can be utilized for personal firearms, and a set of targets that allow a user to replace the live rounds needed for training. These targets can be set up in a user’s residence or any other convenient location, all while providing an inexpensive alternative to live-fire training [12].

3.11 Laser Ammo Training Technologies

Laser Ammo Training Technologies developed an extensive catalogue of products that aim to enable safe firearm training without live ammunition. The company offers programs that display targets (including physical and reactive) and other products intended specifically for military and law enforcement training exercises [13, 14].

3.12 Target Telemetrics

Target Telemetrics developed a “Bullet Group and Shotgun Pattern” analysis software that analyzes a target post engagement to highlight shot groups. This software provides a scoring system for rifle and handgun courses or fire [15]. If needed, there are also custom datasets that can be put into the software to better analyze a target post engagement.

3.13 UNIT Solutions

UNIT Solutions has developed a selection of relatively inexpensive training aids, specifically for simulated rifle engagements, to provide realistic training experiences for military personnel, law enforcement, or professional communities. Although it is limited to only rifle models, the UNIT4 platform utilizes CO₂ propellant and nonlethal marking rounds to provide a realistic environment for training. However, it is not intended for use at a marksmanship qualification course [16].

3.14 Laser Activated Shot Reporter Group (LASR)/Quinfecta Venture, LLC

The LASR team developed a series of products that can be used together to create laser-based ranges wherever desired. Utilizing inexpensive cameras or a smartphone, targets, and a drop-in bolt for any LASR firearm model, an individual can train and capture a video recording of their training/shot groups, their trigger control, and the target acquisition process for further study [17].

4.0 VR Solutions

Like the general hardware and software solutions, there are many VR platforms, engines, and products that are either currently ready for use or close to being finished. They are listed next.

4.1 iMarksman

iMarksman developed a VR platform that can be used by law enforcement or military personnel to simulate virtual training scenarios [18]. There are multiple purchasing and installation

scenarios that provide different trainings. To provide a more realistic training experience, iMarksman developed weapons platforms that have a “blowback” effect when they are used with the VR systems; this blowback effect is intended to emulate what a student would feel during live fire training [19].

4.2 LeadTech

LeadTech developed an application, CLAZER, which utilizes a VR headset and hardware mounted onto a firearm to give a user the ability to practice on moving targets in a virtual space. The training focuses on allowing for clay-bird shooting, with options to change a user’s experience in the application [20].

4.3 HapTech Defense Systems

HapTech developed modular training systems that allow VR, augmented reality (AR), mixed reality (MR), live, and screen-based training sessions. Additionally, drop-in kits can provide realistic recoil that can be tuned as appropriate. The products that HapTech develops also have integrated sensors to allow large amounts of data to be generated for after-action review analysis efforts [21].

4.4 Conflict Kinetics (CK)

CK is an organization that focuses on human performance optimization while operating firearms by measuring several real-time data points throughout training and providing training platforms and video trainings overarching courses to develop proper fundamentals and follow-on skills [22]. One software system, Adaptive Marksmanship, allows productive training sessions without a trainer present. CK develops synthetic pistols, shotguns, rifles, and crew-served weapons paired with their Synthetic Marksmanship Training Systems (SMTS) to provide an end-user with a virtual training session that feels as realistic as possible. They also develop pneumatic drop-in conversion kits to use with an issued firearm so it can interface with their SMTS platforms.

4.5 MILO RANGE/AROTECH

MILO Range developed several platforms that support a single user or multiple users at a given time [23]. Their virtual range technology supports modular programming, which allows up to 60 target lanes, with custom targets, illumination levels, or multiple training scenarios as appropriate [24]. Lethal and non-lethal weapons systems are also a potential selection through training platforms. All training is recordable and can be reviewed in “normal” speed or slowed down to frame by frame to improve a user’s performance and provide guidance. Issued

firearms can have “drop-in recoil kits” replace some issued components to allow usage on MILO’s systems. Some kits include solutions for pistols, rifles, and shotguns. There are additional accessories that can emulate using tasers, mace or oleoresin capsicum spray, batons, pepperball and shotgun beanbag launchers, dry-fire pistols and rifles, and crew-served heavy weapons systems. Additional follow-on training systems outside the scope of a marksmanship setting are also available.

4.6 J&F Alliance

J&F Alliance has a high level of experience in VR, AR, and MR applications. In responding to this effort, they highlighted their capabilities at integrating measurable metrics, such as heart rate, respiration, perspiration, and brain waves, into law enforcement training [25]. Using the organization’s measured metrics and VR ranges and scenarios, shooters can train and track their performance in fundamental skill-building, virtual range training and carry those same skills through development by utilizing custom follow-on training that measures various stress and biometric activity levels in real-time. This data can help determine the most effective training for each individual shooter. J&F can also utilize haptic feedback technology to emulate recoil for weapons systems or realistic response throughout training exercises.

4.7 InVeris

InVeris Training Solutions, formerly Meggitt Training Systems, developed several different synergistic training platforms to augment the training capabilities of the first responder and DoD communities. One of their training platforms, the BlueFire Weapon Simulator, directly answers the focus of this effort when paired with the FATS 100C Marksmanship Training System by providing over 300 weapon variants with realistic recoil, quick recharge capabilities for their magazines, and after-action review capabilities to combine weapon fidelity with a program for accuracy [26]. The FATS 100C Marksmanship platform will track grip, sight alignment, sight picture, trigger control, and recoil management and provide corrective clips for a trainer [27]. Instructors for these courses can program the magazine sizes that will be used and initiate jams through the training to practice immediate or remedial action drills. This specific system supports up to five training lanes at any given time. Follow-on platforms from InVeris can be utilized to develop confidence from scenarios after the fundamentals of proper marksmanship have been achieved.

4.8 Laser Shot

Laser Shot developed the Mobile Marksmanship Training Simulator (MMTS) system, which is a versatile, virtual, training platform that can provide marksmanship training and follow-on scenario-based training and can join multiple screens together to create wider areas of operation or 360° pods for training [28]. The MMTS platform can support up to four marksmanship lanes at any given time and provide immediate feedback to shooters or instructors with subpixel accuracy. The system is intended to be mobile for any realistic training environment, allowing quick construction and calibration efforts to support as much training time as possible. Laser Shot also has additional training platforms for various live-fire or virtual applications. Some capabilities include the modular firearm training ranges, various courses, simulation weapons, recoil-based training systems, and drop-in conversion kits to convert an issued live-fire weapons system.

4.9 VirTra, Inc.

VirTra provides realistic VR training for law enforcement, with an abundance of interactive training capabilities. The purpose of their products is to provide law enforcement officers training opportunities in key areas such as de-escalation scenarios and use of force exercises. The company offers skill drills and unique training scenarios, such as when interacting with dogs on scene or mental conditions. They also have staff members who can create specific interactive scenarios if a tailored course is needed [29].

4.10 Shooting-Soft

Shooting-Soft is a Russian company with software solutions and virtual ranges that can be utilized to practice on cost-effective platforms. They developed many preinstalled scenarios and exercises onto their hardware, as well as an integrated target construction capability where a user can create and place targets they wish to utilize in a custom exercise. A specific application integrated into their kit is an extremely cost-effective electronic shooting range which allows a user to practice firing at virtual paper or virtual plastic targets using their laser weapon models. This laser-firing range operates in real-time, with a scoring system available after receiving the last virtual data point in a predefined exercise.

4.11 Ti Training

Ti Training developed a VR platform called Firing Line, which provides students and coaches with a modular marksmanship training simulator capable of multiple simultaneous lanes [30]. The platform provides realistic settings for up to five shooters per screen. Editor software

internal to the application can be used to change anything from the zones on a target to building an entire custom indoor or outdoor setting. Real-world ballistics and conditions like wind are considered in this platform. Additionally, the company provides interactive classroom training aids and non-lethal training tools [31].

4.12 SMART Simulators

SMART systems developed a training solution software, the ST300, to be a multiscreen, 300° virtual application. It uses replica weapons systems that interface with the screens to give a user the fundamental feel for a weapon while using the training platform [32]. The software gives a statistic and database management center to review trainer-built courses or included scenarios from the manufacturer's internal library.

5.0 Other Solutions

HDIAC found that there were other organizations that can be engaged for this type of effort. Although they did not specifically fall under a hardware or software component that could assist a shooter or coach to better develop the skillset of a student, the National Center for Simulation and Applied Research Associates both had knowledge or capabilities to direct a coach to resources, modern communities, or developers working to augment training capabilities via hardware or software.

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Biography

Daniel Fleming is a research inquiry analyst for the Homeland Defense and Security Information Analysis Center (HDIAC), where he answers technical inquiries and generates research reports on HDIAC's eight different technical focus areas. He has six years of military experience and four years in a clinical pharmaceutical background. During his time in the Marine Corps as a combat engineer, he used his engineering skillset domestically for bridging operations and internationally to assist in humanitarian relief efforts, instructing foreign allied forces, and cross-training on foreign weapons systems across several different locations. He was exposed to domestic qualification courses for live-fire and allied marksmanship and domestic VR platforms to hone marksmanship capabilities. As the lead analytical technician at a Berkshire Hathaway pharmaceutical subsidiary, he executed the established methods for testing various pharmaceutical materials; assisted in developing new site-specific testing methods or training programs; performed registration, storage, and testing for materials; and ensured accurate details in reports generated from tests on thousands of internally or externally developed active drug or excipient suspensions. He also executed an on-site training plan at several stages to ensure compliance to federal regulations.