GIFFORDS LAW CENTER
TO PREVENT GUN VIOLENCE

SECURING A SAFER FUTURE

How Incentives for Gun Safety Technology Can Stop Shootings

giffordslawcenter.org/gun-safety-tech

GIFFORDS LAW CENTER
TO PREVENT GUN VIOLENCE

SECURING A SAFER FUTURE

How Incentives for Gun Safety Technology Can Stop Shootings

Safety technology could make guns far more secure and protect kids and adults from unintentional injuries, suicide, and firearm misuse. But the gun industry has collectively failed to take on the job of designing a safer gun. It's time for policymakers to fund and incentivize the development and sale of gun safety technology so it can start saving lives.

Lifesaving Design Safety Innovations

Gun safety technology allows owners to secure their firearms against access by unauthorized users, like children or household members in crisis. The building blocks of safer, personalized guns (also called "smart guns") already exist. All that's left to do is pair firearms or locking devices with existing technology capable of reliably identifying authorized users, like radio frequency identification (RFID) chips, fingerprint readers, or other biometric sensors.

Gun Safety Developers Lack Adequate Funding

Start-ups and entrepreneurs are finessing new designs for safer firearms, gun safes, and trigger locks. But they've had trouble raising capital to build lifesaving products. Here are the facts:

Cost of building and selling a new firearm design
$20 MILLION

Government grants for gun safety technology
NONE CURRENTLY

Private sector investment in gun safety
1.1% OF INVESTMENT
in comparable industries

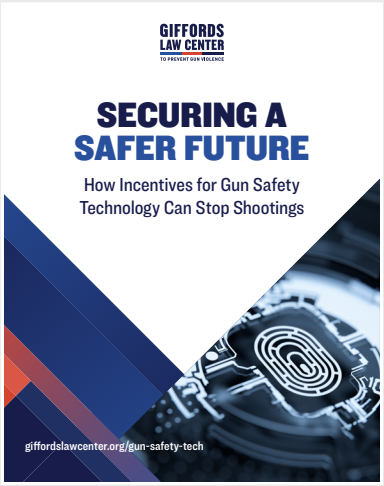
READ THE FULL REPORT

giffordslawcenter.org/gun-safety-tech

FACEBOOK /Giffords TWITTER @GiffordsCourage

READ THE REPORT

Learn more about how guns and locking devices equipped with gun safety technology can make firearms more secure and stop tragedies before they occur.



A DECADE OF RAPID DEVELOPMENT

Due to recent technological advancements, gun safety developers now have the benefit of more reliable fingerprint sensors, faster biometric algorithms, and smaller RFID chips. Demand also surged over the same period: a 2016 survey shows that 43% of gun owners would buy a personalized gun.

43% of gun owners would buy a personalized firearm.

INCENTIVES TO FUND GUN SAFETY

Connecting gun safety start-ups with funding is critical for ensuring that safer firearms reach store shelves. But a new approach is needed to counter entrenched opposition from the NRA and gun manufacturers. These groups have deterred private investment by framing gun safety technology projects as risky. There's a powerful way to counter the gun lobby's obstructionism: government grants and financial incentives to support gun safety entrepreneurship and close the funding gap for safety technology start-ups. The right policy incentives can ensure personalized guns and accessories are actually developed and sold—and start saving lives—as soon as possible.

OPTIONS FOR INCENTIVES

To encourage businesses and entrepreneurs to develop safer firearms, and to strengthen the market for gun safety technology, the federal and state governments should consider the following approaches:

- **Targeted grants.** Grants could be offered to companies or small businesses meeting specific benchmarks.
- **Developer or consumer tax credits.** Companies that develop gun safety technology could qualify for tax credits, or purchasers could receive a tax credit.
- **Consumer rebates.** A percentage of the purchase price could be offered as a rebate to consumers who buy a personalized gun or security accessory.
- **Tax breaks.** Qualifying firearms could be exempted from federal excise taxes and sales taxes.

INCENTIVE MODELS FROM OTHER INDUSTRIES

In the automobile and other industries, lifesaving technological advancement was achieved only after the US government used incentives to spur innovation and entrepreneurship. The results jumpstarted stagnant industries and led to real progress, including the development of drugs to cure rare diseases, new sources of clean energy, and car safety technology. It's the urgent responsibility of our state and federal governments to fund the same type of programs for gun safety—especially because the private gun industry has failed to take any action to reduce preventable gun deaths.

GUN SAFETY TECHNOLOGY COULD:

Reduce the 21,000 gun suicides per year.

Protect the 4.6 million kids living with easily accessible guns.

Prevent gun crimes and assaults with the 500,000 guns stolen every year.

WE'RE ON A MISSION TO SAVE LIVES

For 25 years, the legal experts at Giffords Law Center to Prevent Gun Violence have been fighting for a safer America by researching, drafting, and defending the laws, policies, and programs proven to save lives from gun violence. Founded in the wake of a 1993 mass shooting in San Francisco, in 2016 the Law Center joined with former Congresswoman Gabrielle Giffords to form a courageous new force for gun safety that stretches coast to coast.

CONTACT US
media@giffords.org

READ THE FULL REPORT

giffordslawcenter.org/gun-safety-tech

FACEBOOK /Giffords **TWITTER** @GiffordsCourage

Welcome

For too long, the gun industry has shirked its responsibility to the American people, failing to make any efforts to design products that reduce the risk of gun violence. The price of their indifference is thousands of lives every year, many of them children.

Securing a Safer Future: How Incentives for Gun Safety Technology Can Stop Shootings represents an entire year of research and analysis by Giffords Law Center's legal and policy experts on how technology can be used to save more of those lives. And what we found gave us cause for hope. As dismal and daunting as our gun violence crisis is—over 155,000 Americans shot in 2016 alone—concrete, effective solutions exist. We just have to implement them.

The stakes are high. At least 4.6 million American kids live in homes where firearms are kept unlocked and loaded, and poorly secured guns have caused unintentional deaths, teen suicides, homicides with stolen guns, and even mass shootings. The week I drafted this letter, a 17-year-old in Santa Fe, Texas, used his father's guns to kill 10 students and teachers at his high school. It doesn't have to be this way.

Start-ups have already designed guns and accessories that use technology like fingerprint scanners to prevent unauthorized users from accessing weapons. The potential to save lives is enormous, and consumer interest in personalized guns is high. Yet, thanks to gun lobby boycotts and bullying, most of these products are not yet available. If we want to protect our kids and communities, it's imperative that policymakers fight obstructionism with bold policies that encourage investment in developing safer guns. The incentives outlined in *Securing a Safer Future* are designed to guide the way for lawmakers with the courage to fight for advancing technology that can prevent so much tragedy.

The Smart Tech Challenges Foundation, which provides grants to innovators working on gun safety technology, proved critical in helping us understand the products in development and the funding gap gun safety start-ups face. Learn more about their efforts to save lives at **smarttechchallenges.org**.

Our work on gun safety technology doesn't stop with this report. Legislators and advocates interested in partnering with our attorneys to develop legislation that will encourage innovation to make guns safer, protect children, and disrupt the firearm industry should email us at **lawcenter@giffords.org**.

With gratitude,

Robyn Thomas

ROBYN THOMAS
Executive Director
Giffords Law Center
to Prevent Gun Violence

Contents

INTRODUCTION

The technology to create safer guns already exists—manufacturers just need the proper incentives to build them.

In 2018, it's stating the obvious to say that technological innovation has transformed American life. Ninety-eight percent of people in the US now use high-speed, wireless internet and about 75% have smartphones—unthinkable percentages just 10 years ago.[1] Millions of Americans own high-definition TVs, energy-efficient appliances, and hybrid cars. Many of the most meaningful technological advancements in recent years have been in the realm of public health and safety—immunotherapy drugs have saved the lives of cancer patients, defibrillators have helped people survive heart attacks, and electronic stability control has reduced car accident injuries.

Aside from headline-grabbing breakthroughs like these, simpler mechanical inventions have also saved many lives. The three-point seat belt has protected millions since its introduction in 1959.[2] Childproof medicine caps significantly cut child overdose deaths after being adopted in the 1970s.[3] Car seats for young children, which became widespread in the 1980s, reduce infant mortality from crashes by up to 71%.[4] These innovations were so simple and powerful that today we barely notice them, yet without them Americans, and American children in particular, would be at much greater risk of pain, injury, and death.

BUILDING A 21ST-CENTURY GUN

There is one prominent area where innovation has not kept pace with other industries: guns. With over 300 million guns in America, it's shocking how little progress has been made toward building a *safer* firearm. Guns already work well for the purpose of firing bullets: the 125,000 victims of gun violence each year in the United States are tragic proof of these machines' lethal efficacy.[5] But there are mechanical and technological innovations that gun manufacturers can and should adopt to make firearms *safer*, innovations that would reduce unintentional shootings of children, allow owners to better secure their guns from theft, and prevent household members in crisis from using a gun to harm themselves or others.

The most promising innovations allow gun owners to secure their firearms using safety technology, also called "smart gun" or "personalized gun" technology. Gun safety technology ensures that a weapon can only be fired by an authorized user, employing fingerprint sensors, radio-frequency identification (RFID) chips, or other means to personalize a firearm, safe, or locking device and reliably secure the gun against unauthorized access. The benefits of using safety technology to secure firearms are immense. By letting owners control who has access, this technology can prevent suicides, stop unintentional shootings, and discourage gun theft.[6]

The potential beneficiaries of gun safety technology include kids like Alicia, a bright 12-year-old from Seattle who had become unhappy at school and started exhibiting symptoms of depression.[7] In a moment of crisis, the girl jimmied the lock to the bedroom where her grandparents kept their gun and used the weapon to take her own life. It was only after her death that her father learned that Alicia's grandparents had a loaded gun in their home—and that Alicia knew where it was.[8] Her father believes his daughter did not fully understand what she was doing when she broke into the room, but that even a light pull of the gun's trigger was enough to turn her suicidal impulse into a devastating reality.[9] Research supports this view, with studies showing that youth suicides are often highly impulsive,[10] meaning that if Alicia hadn't been able to find and fire a gun, her life would not have ended as it did, and may not have ended at all.

Gun safety technology ensures that a weapon can only be fired by an authorized user by personalizing a firearm, safe, or locking device.

Using technology to improve firearm security and save the lives of children is far from a futuristic pipe dream. It's not a dream at all, because personalized guns and locking accessories are already in development. Nor is the underlying technology futuristic. The innovations required to secure a gun are well-established and time-tested. RFID chips, which use radio waves to identify objects, were invented decades ago, and today RFID technology works reliably in everyday devices like car keys and

building access cards. Fingerprint recognition has been built into smartphones for years and is used by millions of people around the world, and these devices are in some ways more technologically complicated than guns.

What's more, we know gun manufacturers are capable of pairing technology with firearms. They've certainly been willing to work with advanced technology, including electronics and internal computers, in order to make guns more *lethal*.[11] The gun industry is also plainly more than capable of marshaling the resources to develop and sell new products. Gun companies have invested in the development and marketing of numerous lethal accessories in recent decades, including large-capacity magazines, bumpstocks, laser scopes, and silencers.

It is simply unconscionable that the gun industry has refused to make it a priority to leverage these same advancements to make their products safer in order to help reduce youth suicide and other preventable gun deaths.

WHY ARE GUNS DIFFERENT?

We know that gun safety technology already exists and has the potential to save lives. But with almost no exception, major players in the firearm industry have avoided their responsibility to even explore technology to personalize or better secure firearms. Instead, they're carrying on with business as usual, not only continuing to produce traditional firearms, but also devoting resources to building hyper-dangerous accessories, like laser sights and bump stocks. None of this energy has been directed to designing a *safer* gun.

All this begs the question: why is gun safety so far behind other industries, like cars, medicine, and consumer electronics? Why is the firearm industry the exception to the rule governing every other American industry—the rule that technology can improve product safety and save innocent lives?

The answer is that the gun industry seems to view its business simplistically, as following a formula it cannot—or doesn't want to—change. For too long, the industry has been operating under

INCREASING FIREARM LETHALITY

BUMP STOCKS

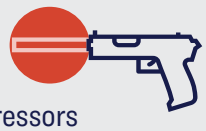
Bump stocks help shooters simulate automatic fire and in 2017 were used to kill 58 people and wound hundreds more in Las Vegas.[i]

LARGE-CAPACITY MAGAZINES

Magazines that hold 10 or more rounds allow shooters to kill more people more quickly, without reloading, and are a favored tool of mass shooters.[ii]

LASER SCOPES

In 2013, one gunmaker created a "smart rifle" that pairs a laser scope with an internal computer, giving novices the long-range accuracy of a trained sniper.[iii]



SILENCERS

Silencers and suppressors mask gunshots and have been used to assassinate police. Yet the gun lobby has made deregulating them a top legislative priority.[iv]

the fear that investing in safety advancements could cut into sales of traditional firearms or draw the public ire of the NRA's extremist leadership. The business model the industry sticks to is that it profits from the production and sale of firearms and that's the end of the story. By treating suicide, criminal misuse of firearms, and unintentional shootings as problems for others to worry about, gunmakers profit from gun sales while avoiding responsibility for the *consequences* of gun sales. The industry has been given special license to think this way, in part because federal law exempts firearms from being regulated under consumer product laws[12] and gives gun manufacturers immunity from being sued in court over their products.[13]

HOW TO CHANGE THE FORMULA

Though the gun industry is unique in some ways, the "formula" described above is actually a fairly common barrier to technological progress. Progress often stalls when the incentives of a given industry are not aligned with the public's interest in product safety. Gun companies aren't the ones who suffer when a toddler dies or a relative in crisis commits suicide. So why should they change anything? It is simpler for the industry to promote a fiction that *no* design changes would be capable of saving lives and that we have no choice but to accept the daily tragedies that gun safety technology could avert.

Fortunately, history shows us that this brand of cynical thinking is not likely to last. For instance, in the 1970s, auto manufacturers vehemently lobbied against airbags, including because of their cost.[14] But over the next two decades, airbags saved so many lives that opposing them became unconscionable—and now car companies use safety features like airbags as a selling point. Technology has a way of doing that: when it works, it is unstoppable.

Getting to the point where personalized guns are widely available requires changing the gun industry's formula for doing business.

But gun safety technology can't save a single life until it is actually on the market. Getting to the point where personalized guns are widely available almost certainly will require changing the firearm industry's formula for doing business. This formula has encouraged the industry and its lobbying groups not only to avoid developing gun safety technology, but also to organize boycotts to stop retailers from selling safer firearms and to obstruct state legislation that would ensure personalized guns are sold once the technology is available.[15]

Securing a Safer Future: How Incentives for Gun Safety Technology Can Stop Shootings tackles the fundamental question of how to change the gun industry's entrenched approach to doing business so that fewer lives will be lost to gun violence. The most promising answer to that question is that the government must provide incentives for businesses and entrepreneurs to develop personalized guns, safes, and locking devices. Realistic progress requires an understanding of the gun market, existing gun safety technology, and promising technology in development. The body of this report will cover these topics and lay out a blueprint with specific recommendations for how policymakers can encourage gun manufacturers, entrepreneurs, and investors to advance public safety by developing and supporting safer firearm designs.

Specifically, the report will:

- **Describe the current state of gun safety technology.** There are two main types of technology used in personalized guns and accessories: RFID chips and biometric recognition. Both are reliable and, when paired with a gun or locking device, show significant potential to save lives from suicide, unintentional shootings, and gun thefts.
- **Forecast where gun safety technology is heading.** Many innovators are seeking to improve on existing technology and guide industry-transforming ideas from the drawing board to the marketplace. The report profiles leading gun safety innovators and describes their inventions, their lifesaving applications, and the work that remains left to do.
- **Describe consumer preferences and legislation around smart guns.** Demand for this technology is strong: up to 7 in 10 American gun owners are open to buying a "childproof" personalized gun as their next handgun purchase. Laws have the potential to respond to this consumer demand, and thus far, three states have legislated in the area of gun safety technology.
- **Recommend incentives to create access to the safer firearms consumers want and expect.** There are legislative opportunities to support gun safety technology through policies that incentivize technological innovation. The right incentives will encourage the development and sale of personalized guns and accessories by leveraging market forces and responding to developers' needs.

It took the auto industry decades to accept the idea of including airbags in cars, and these airbags now save many thousands of lives every year.[16] Today, Americans in 21 states are more likely to die from a gun injury than they are in an automobile accident.[17] It is the gun industry's turn to join the 21st century by developing and offering technologically advanced firearms to consumers who wish to purchase them. This report outlines a path to that future.

EXECUTIVE SUMMARY

Gun safety technology can make deadly weapons far more secure and save many American lives.

With over 300 million guns in America, it's shocking how little progress has been made toward building a *safer* firearm. Guns already work well for the purpose of firing bullets and ending lives. But there are mechanical and technological innovations manufacturers could adopt to make firearms considerably safer for gun owners and everyone else, by ensuring that an owner's firearm can't be fired unintentionally or used against them by an assailant.

The most promising innovations involve pairing firearms with security technology, like a fingerprint sensor or electronic chip, that lets owners control who can access their guns. Secure firearm technology can help prevent suicide and unintentional shootings, secure guns against theft, and guard against access by household members in crisis.[18] This technology could help prevent tragedies like the suicide of 12-year-old Alicia, a young girl who struggled with depression and took her own life after breaking into a room where her grandparents kept a gun.[19] Many youth and teen suicide attempts are impulsive and tied to firearm availability,[20] meaning if Alicia hadn't been able to fire a loaded gun, there's a good chance she would be alive today.

The idea of a safer firearm isn't science fiction. The technology needed to make guns more secure already exists, and what's more, we know manufacturers are capable of pairing technology with guns. They've certainly been willing to work with advanced

electronics in order to make guns more *lethal*.[21] But at the behest of the NRA,[22] leading manufacturers have declined to explore innovations to improve gun safety.[23] Instead, the gun industry and corporate gun lobby has prioritized profits from traditional firearms while disclaiming their urgent moral responsibility to develop safety technology.[24] By resisting innovation, the gun lobby is not only compromising public safety, but also defying consumer preferences—because there is high demand among the American public for safer firearms.[25]

The NRA and gun manufacturers shouldn't be able to falsely claim that there's no way technology can improve gun safety and save lives. We know better. Industries throughout history have embraced progress by using new technology and mechanical inventions to power safety innovations, like when the automobile industry developed airbags, antilock brakes, and electronic stability control. Today, CDC data shows that more Americans die from gunshots than in car accidents.[26] There are over 38,000 gun deaths annually, but isn't just *one* preventable death too many? Isn't it unacceptable for even one family to suffer after a young person's suicide or unintentional shooting? It is unconscionable that the gun industry seems to have accepted mass death and trauma as normal instead of doing everything in their power to prevent innocent lives from being lost.

In the 1970s, automakers lobbied against airbags—but over the next 20 years, airbags saved so many lives opposing them became unthinkable.

With so many lives at stake, it's time for policymakers to counter gun lobby inaction with laws and programs to meet consumer demand for gun safety features and help bring firearms into the 21st century. Entrenched opposition from the gun industry and the NRA means any effective policy response will require disrupting the industry's cynical formula for doing business. One way to do that is by proving that lifesaving safety technology *can be built and will work*. This is a time-tested strategy: in the 1970s, automakers lobbied against airbags, citing their cost and other factors.[27] But over the next 20 years, airbags saved so many lives that opposing them became unthinkable. Technology has a way of doing that: when it works, it's unstoppable.

The gun industry's opposition to gun safety innovation demands a powerful new approach—one that will harness market forces to ensure that safety technology is developed and brought to market, where it can become unstoppable. Policymakers should take decisive steps to overcome gun lobby obstructionism by funding start-ups that are researching and developing lifesaving gun safety technology and by implementing incentive programs to attract new entrants to the market. The right policy incentives can ensure that advanced firearms and accessories are actually developed and sold—and start saving lives—as soon as possible.

WHAT IS GUN SAFETY TECHNOLOGY?

Understanding the incentive programs capable of revolutionizing gun safety requires a closer look at what types of safety technology can best protect gun owners and the public. Many people were introduced to the concept of a personalized gun in the James Bond movie *Skyfall*, in which 007 carries a handgun that unlocks with his palm print. When the villain grabs Bond's gun, he can't shoot it, so Bond survives what would otherwise have been a deadly encounter.
A personalized gun—also referred to as a "smart gun"—uses safety technology to limit access to authorized users.

Gun safety technology includes personalized smart guns, but also accessories like gun safes, trigger locks, and retrofit kits.

James Bond's smart gun is a famous example, but the term "gun safety technology" actually describes a broader category of advancements that improve the security of firearms by guarding against unintentional shootings, firearm misuse, and criminal assaults. Gun safety technology includes personalized smart guns, but also accessories like gun safes, trigger locks, and retrofit kits that help keep firearms secure. Gun safety technology could also include mechanical innovations that exclude child access better than existing gun locks.

- **Personalized guns** let owners control who accesses their gun. The methods used to give owners this control include biometric security features, like fingerprint sensors or grip recognition, and radio-frequency identification (RFID) technology, which uses radio waves to identify objects.
- **Personalized accessories**, like a fingerprint trigger lock, add an extra layer of security to gun safes or locks. When used with traditional guns, they offer a similar level of security to personalized guns.

It is also possible to make guns safer with mechanical innovations that don't use technology. For instance, a gun's trigger could be secured with a mechanical lock that opens with a motion kids have difficulty performing, such as pressing multiple buttons simultaneously or depressing fingers in a certain pattern. The right combination of mechanical and technological innovations could make guns toddler-proof or child-resistant, a development that would transform gun safety in America—ensuring fewer families have to live in fear of their child dying from a gunshot wound.

THE BUILDING BLOCKS OF A SAFER GUN

The technological innovation needed to make guns more secure and bring peace of mind to families is not light-years ahead of us—it already exists. What's left to do is straightforward: pair guns and accessories with security technology that is capable of identifying authorized users. The best approach will leverage reliable *existing* technology to guard against access by children or other unauthorized shooters.

RFID technology, invented in the 1970s, uses radio waves to communicate a unique numeric identifier from a chip to a reader.

One of the leading candidates is RFID technology, which uses radio waves to communicate a unique numeric identifier from a chip to a reader. RFID chips were invented in the 1970s and are used today in everyday devices, including car key fobs, automatic toll payment systems, and building access cards.[28] Another promising technology uses biometric recognition to detect identifying biological features, such as a fingerprint, palm print, or grip. Fingerprint and palm print sensors have already been incorporated into some gun safes and trigger locks.[29]

LIFESAVING BENEFITS OF GUN SAFETY INNOVATION

Using reliable, existing technology to improve gun safety could save many lives by reducing suicides, unintentional shootings, and crimes committed with stolen guns.

PREVENTING GUN SUICIDES BY ADULTS AND TEENS

21,000 Americans die from self-inflicted gunshots each year, and people who attempt suicide with a gun are far more likely to die than if they attempt suicide with other methods.[30] Most people who attempt suicide communicate warning signs in advance, which means gun safety technology could create a lifesaving window of opportunity for owners to revoke access to a gun by a suicidal relative or friend.[31] Technology could be especially critical in preventing teen suicides, because immediate gun availability is a leading contributor to suicides in this age group.[32]

PROTECTING KIDS FROM UNINTENTIONAL SHOOTINGS

Secure firearm designs can also prevent tragic unintentional shootings involving children. A 2018 study found that there are 4.6 million American children living in homes where loaded firearms are stored unsafely,[33] and American *toddlers*—children under age four—are involved in unintentional shootings about once a week.[34]

Even children whose parents do not own guns are at risk when they find a firearm at a friend or neighbor's house. Many of these tragic shootings could be averted if adults used security technology or mechanical innovations to prevent kids from firing guns.

PREVENTING CRIMES AND GUN THEFTS

Another compelling way safety technology can protect the public is by stopping thieves from committing assaults and other crimes with stolen guns. Each year about 350,000 private citizens report gun thefts, accounting for 500,000 total firearms annually.[35] Stolen guns are easy to resell and can be trafficked from states with lax gun regulations. About 10–15% of stolen guns, or tens of thousands every year, are later used in crimes.[36] Personalized guns could reduce these crimes and save gun carriers' lives in "gun-grab" situations.

BARRIERS TO THE MARKET FOR SAFER FIREARMS

Gun designs leveraging advanced technology could transform public safety to the benefit of many American children, families, and communities. Unfortunately, while RFID chips and biometric recognition are widely used in other contexts, neither technology has been incorporated into any firearm sold in US retail stores. One independent developer has built and tested a reliable RFID shotgun,[37] but has not manufactured or sold it. Biometric technology has been incorporated into safes and locking devices that are currently being sold, but not an all-in-one firearm.[38]

Major players in the American gun industry have ducked their responsibility to even explore gun safety technology.

We know that existing safety technology can save lives when incorporated into a gun or locking accessory. But with almost no exception, major players in the American gun industry have ducked their responsibility to even explore this technology. Instead, they're continuing business as usual, not only producing traditional firearms, but also directing resources to building hyper-dangerous accessories, like laser sights and bump stocks.[39] None of that energy has been directed to designing a *safer* gun.

Why haven't manufacturers taken the opportunity to bring gun designs into the 21st century? It is likely that a combination of factors, discussed below, has led manufacturers to avoid or oppose safety innovations.

GUN LOBBY EXTREMISM HAS DETERRED INNOVATION

The NRA claims it "doesn't oppose the development of 'smart' guns, nor the ability of Americans to voluntarily acquire them."[40] But in fact, the NRA has repeatedly opposed gun safety innovation.

- In 2000, the NRA led boycotts against Smith & Wesson after the company settled litigation over its firearm designs by agreeing to dedicate resources to developing personalized guns. After boycotts nearly drove the company out of business, Smith & Wesson reneged on the agreement.[41]
- In 2002, the NRA opposed New Jersey's first-of-its-kind law requiring that personalization technology be included in handguns sold in the state after viable technology is commercially available, which was intended to incentivize safer firearm designs by guaranteeing a state market for them.[42]
- After unsuccessfully opposing New Jersey's law, the NRA poured its energy into stopping the law from being implemented—by pressuring and intimidating companies who expressed any interest in developing or selling a personalized gun into abandoning their plans.[43]

The NRA's obstructionism suggests that the group's real position is that the gun industry has no part to play in reducing gun deaths. This cynical stance is a convenient one to take: it absolves gunmakers of responsibility for improving gun designs and protects their profits from sales of traditional firearms. But the narrative that gun deaths are inevitable is false and has been dismantled time and again by public health experts[44] and survivors of gun violence.[45] Unfortunately, by adopting an extreme position and punishing manufacturers who depart from it, the NRA has deterred the gun industry from exploring safer designs.

RISK INTOLERANCE AND COST SENSITIVITY

Gun mechanics may make some manufacturers reluctant to pursue safety innovations. The internal mechanics of traditional firearms have barely changed for a century.[46] The constancy of these designs—and consistently high sales—may make gunmakers nervous to experiment with new technology. Of course, history teaches us that resisting progress is often the wrong choice. Manufacturers who oppose safety innovation are running the risk that they're positioning themselves as horse-and-buggy companies just before the introduction of the Model T.

Production cost concerns may also foster resistance to innovation. But the same manufacturers who claim it's infeasible to fit electronics into guns have proven eager to use technology to make firearms more lethal.[47] Manufacturers willing to work with technology to make guns safer will have a leg up once safety features gain a significant enough market foothold to make producing them a necessity.

GUN INDUSTRY OPPOSITION CREATES AN OPENING FOR START-UPS

The gun lobby's opposition to technological development and manufacturers' failure to innovate is disappointing. But it isn't all bad news: the gun industry's slow-moving business model creates opportunities for individual entrepreneurs and start-ups.

TECHNOLOGY IS IMPROVING AND DEMAND IS INCREASING

Current conditions are ripe for small companies to make big strides toward gun safety innovation. Over the last two decades, safety technology and the market for personalized guns have both undergone transformative changes. The underlying technology has improved significantly, with more reliable fingerprint sensors, faster biometric algorithms, and smaller RFID chips becoming available.[48] At the same time, demand for safer firearms has surged. In 2016, the first peer-reviewed poll on personalized guns showed that 43% of gun owners would buy a personalized gun if one were on the market.[49] This comes out to almost 24 million prospective buyers.[50]

START-UPS ARE BUILDING ON FAVORABLE CONDITIONS

Entrepreneurs have already started leveraging developments in safety technology and consumer demand. In recent years, companies have produced and sold biometric gun safes and a lock that can be unlocked with a fingerprint. At least half a dozen companies are selling biometric safes, and one start-up is selling a biometric trigger lock—the Identilock—that attaches to handguns and unlocks in 3/10 of a second.[51] In addition to what's already on the market, several innovators have conceived new designs to make firearms safer for owners, families, and the public.

A sample of gun designs that have already been built or are in development:

- A handgun from Biofire Technologies that will unlock with a fingerprint sensor in less than half a second.[52]
- A handgun from iGun Technology (which developed a smart shotgun in 1998) that pairs with an RFID token ring that may be worn under gloves or with wet hands.[53]

A sample of accessories in development:

- An aftermarket grip for the AR-15, GunGuardian, designed by law enforcement officers, that will lock the trigger using one of several methods.[54]
- A biometric firearm safe, Reach, for homes and vehicles, that uses an intuitive fingerprint sensor that can reduce unlocking time to 0.5 seconds.[55]
- A biometric gun lock, Identilock, that is already being sold for use with some handguns, and will be expanded to additional handgun models.[56]

GUN SAFETY START-UPS NEED MORE FINANCIAL SUPPORT

The gun industry's entrenched opposition to safety innovation helps explain why leadership in this area is not coming from big manufacturers, but from start-ups. These companies show that progress is possible—they have a track record of doing cutting-edge work, conceiving bold ideas, and advancing them toward the market. Unfortunately, however, many start-ups with lifesaving ideas have been unable to get all the funding needed to advance their ideas to market. A "funding gap" remains—and closing it is imperative in order to put gun safety technology on store shelves.

GUN SAFETY DEVELOPERS LACK ADEQUATE FUNDING

Despite increasing demand and strides in technology, firearm safety innovators have faced difficulties raising enough capital to build market-ready products. Gun safety technology experts interviewed by Giffords Law Center estimate that it will take at least $20 million to bring a new design from the drawing board to store shelves. Since there is virtually no targeted government funding in this area, new companies must get this money from the private sector, including private investors and venture capital firms. But three major problems have inhibited these sources of private funding for gun safety technology.

PERCEIVED POLITICAL RISK

Leading US gun manufacturers have the resources to fund innovation—if they want to. But influenced by hardline opposition from the NRA, these manufacturers have overwhelmingly chosen not to develop personalized guns and accessories.[57] The industry's failure to lead has had a ripple effect, creating a pervasive perception that developing safer firearms is politically risky.[58] Safety technology developers now must worry that they and prospective retail sellers will be subjected to NRA boycotts, and investors fear that political opposition and retailer boycotts will shrink their return on investment.[59] As a result, investors may choose to avoid this area entirely.

The risks of investing in gun safety technology may be more about perception than reality—there is high consumer demand for personalized guns.

The risks of investing in gun safety technology may be more about perception than reality. There is high consumer demand for personalized guns,[60] and past experience—like the auto industry's opposition to airbags—suggests any boycotts would be short-lived once advanced firearms start to confer safety benefits. But the *perception* of risk may inhibit some technology from getting off the drawing board.

MISCONCEPTIONS HAVE RESULTED IN MISSED INVESTMENT OPPORTUNITIES

Venture capital (VC) firms have also complicated gun safety start-ups' efforts to secure adequate private funding. Between 2006 and 2015, only six firearm technology companies received VC funding worth $110 million.[61] While this may sound large, it is actually a much lower level of investment than other industries—for example, $110 million is only about 1% of VC funding for the cybersecurity industry.[62] These numbers are considerably lower than might be expected considering the estimated 55 million US gun owners,[63] the potential for a safer gun to capture significant market share, and the lives that could be saved with this technology.

What explains low investment levels? VCs are influenced by political risks, which means that the threat of NRA boycotts has raised the perceived risk of investing $20 million in gun safety technology. But an additional likely explanation is that VC funding tends to follow entrenched formulas, with money more likely to go to ideas that are similar to past investments.[64] This pattern suggests VCs may be overlooking opportunities to finance safer firearms, because it is a new investment frontier that does not fit any mold. The fact that gun ownership is concentrated in regions outside of VC hubs like Silicon Valley in California may also contribute to a sense that guns are "outside the lane" of investors or too controversial. And VCs' familiarity biases could create a mistaken impression that gun safety can't be profitable, even though there is a potential market of 24 million people, and gun violence costs the US $229 billion each year[65]—far more than the $20 million it takes to fund a gun safety technology project.

The above doesn't just identify a problem with VC decision making—it also points to a solution to drive further investment. Investors might be steered toward gun safety projects if they could be persuaded to evaluate their merits and lifesaving potential, rather than following instincts to focus on the familiar or letting NRA scare tactics drive their decision-making.

GUN INDUSTRY REVENUE IS $8 BILLION PER YEAR

THE COST OF FUNDING A GUN SAFETY TECHNOLOGY PROJECT IS $20 MILLION

TESTING AND PRODUCTION COSTS EXCEED EXISTING GRANTS

Although VC funding is at low levels, in some cases individuals have stepped up and offered grant money to fund lifesaving designs. In 2013, Ron Conway funded the Smart Tech Challenges Foundation, which awarded a total of $1 million in grants to 15 innovators with designs for safer firearms and accessories.[66] Today, the foundation is a leader in the field, and its grants have been a significant source of funding for gun safety entrepreneurs. However, as it stands now, most developers need even more capital to get to a market-ready stage of development. The expenses of building, testing, and manufacturing a new gun or accessory are significant, with costs totaling an estimated $20 million. Grants from Smart Tech Challenges Foundation have been impactful, but far more is needed to completely close the funding gap.

A POWERFUL NEW APPROACH: INCENTIVE LEGISLATION

Until personalized guns and safer accessories are actually being sold, lives can't be saved with this promising technology. A handful of entrepreneurs have conceived viable designs that leverage cutting-edge technology, but they need more investment to get these technologies to market.

Unfortunately, as discussed above, solutions previously proposed to bridge this funding gap have had a mixed record:

- New Jersey's legislative mandate drew a backlash from the gun industry, and the gun lobby's opposition and extremist rhetoric has hindered innovation.
- Private investment has been low, in part because of perceived political risk.
- Individual grants have provided some needed cash, but grants totaling $1 million were not enough to fully cover development and testing costs.

At the same time, technology and the market have undergone transformative change:

- More reliable fingerprint sensors, faster biometric algorithms, and smaller RFID chips are available.
- Demand has surged: 43% of gun owners would buy a personalized gun.

In short, circumstances have changed dramatically since the first policies were proposed to support the development of gun safety technology. These changed circumstances merit a change in tactics to get safer gun designs to market. It is clear that gun safety technology needs a financial boost, but it is also clear that the technology is closer than ever to being ready—and that past approaches have not been fully effective at boosting gun safety technology across the finish line.

In light of changed circumstances, how should policymakers support this technology? The most promising approach, modeled after other industries, is to offer financial incentives to gun safety technology developers.

INCENTIVES TO DRIVE SAFETY TECHNOLOGY FORWARD

In the automobile and other industries, lifesaving mechanical and technological advancements were achieved only after the government used financial incentives to reward companies who manufactured and consumers who used safer products.[67] The results jumpstarted stagnant industries and led to real progress, like the development of lifesaving pharmaceutical drugs and car safety technology.[68]

It is the urgent responsibility of our state and federal governments to fund the same type of programs for gun safety—especially since the firearm industry has avoided taking any action to prevent America's epidemic of gun deaths.[69] To encourage the development of safer firearms, and to strengthen the marketplace for safety technology once it is widely available, policymakers should implement the same focused incentives that have worked in other industries.

THE BENEFITS OF INCENTIVE LEGISLATION

Incentive legislation would help narrow the "funding gap" hindering the development of gun safety technology by working with market forces to make it more attractive to develop and purchase safer firearms and accessories. For example:

- Some incentives, like **targeted grants**, would directly connect small businesses and gun safety technology entrepreneurs with the remaining funding they need to produce safer firearms and more secure accessories.
- Other incentives, like **tax credits**, would encourage investors to furnish additional funds by offsetting costs and increasing future profit margins.
- Enacted instead of legislative mandates, some incentives could encourage investment by **reducing the perceived heightened risk** of investing in safety technology and avoiding extremist critiques from the corporate gun lobby.

OPTIONS FOR INCENTIVES

To encourage the gun industry to develop safer firearms, and to strengthen the marketplace for safer guns, the federal and state governments should consider the following incentive-based approaches.

SUPPLY-SIDE INCENTIVES

Policies that have created incentives for technological innovation in other industries include commercialization readiness grants, tax credits, and tax exemptions.

Commercialization Readiness Grants: Grants could be offered to companies meeting benchmarks, like reliability testing, or planning to market and produce a safer firearm or locking device. The grants could be modeled after the National Institute of Health's Small Business Innovation Research (SBIR) program and Commercialization Readiness Pilot (CRP) Program.[70]

Tax Credits: Companies that develop safety technology could qualify for tax credits, modeled after those that incentivize the manufacture of energy-efficient appliances,[71] production of renewable energy,[72] or development of drugs for rare diseases.[73]

Tax Exemptions for Developers: There is a 10–11% federal excise tax applicable to gun sales by manufacturers, producers, and importers.[74] Manufacturers could be exempted from having to pay the excise tax for qualifying firearms equipped with gun safety technology, reducing their costs of selling them to retailers.

DEMAND-SIDE INCENTIVES

Effective incentives could include rebates and tax credits and exemptions.

Consumer Rebates: A percentage of the purchase price could be offered as a rebate to consumers who buy a firearm or accessory equipped with gun safety technology—similar to rebates offered for energy-efficient appliances.[75]

Tax Credits and Sales Tax Breaks: Consumers purchasing gun safety technology could also receive a tax credit, like those offered for alternative fuel source motor vehicles.[76] Buyers could also be eligible for sales tax breaks. Several states already exempt buyers of trigger locks and gun safes from sales taxes, and one state—New Jersey—exempts devices that limit access to a firearm by unauthorized users.[77]

FUNDING GRANTS THROUGH A FIREARM BUSINESS TAX

Legislatures seeking to fund grant programs could consider taxing manufacturers and sellers of traditional guns and lethal accessories, like laser sights, bump stocks, or large-capacity magazines.[78] The proceeds could fund grants for small businesses developing safety technology.

INCENTIVES FOR A SAFER FUTURE

Our goal in researching the market for gun safety technology is not to prescribe specific incentives, but to offer a menu of options for policymakers to consider. Incentives may need to be designed in consultation with tax experts and economists, who may develop methods to spur technological development beyond the ideas presented here. In part because incentivizing a robust market for safety technology requires bold thinking and experimentation, in conjunction with careful design innovation by entrepreneurs and start-ups, the results may be years in the making.

But at the finish line of all this is an America where gun owners can choose the security of acquiring child-resistant weapons or storing traditional firearms in secure gun safes or with advanced trigger locks. This will be an America where fewer kids and adults die from gun accidents and suicides or are assaulted with a stolen gun. It is our collective duty to craft effective economic incentives for gun safety technology that can bring our country to that safer future.

HOW INNOVATION SAVES LIVES

Personalized guns, trigger locks, and safes can prevent suicide, stop unintentional shootings, and discourage gun thefts.

Many people were introduced to the concept of gun safety technology in the James Bond movie *Skyfall*, where 007 carries a gun that unlocks with his own palm print. When the villain steals Bond's gun, he can't shoot it, so Bond survives what could have been a deadly encounter. This is a classic example of a personalized gun (often called a "smart gun"), which uses technology to ensure only authorized users can fire it.

Personalized guns like the one in *Skyfall* are one type of gun safety technology. However, the term defines a broader category of gun safety advancements that guard against unintentional and criminal shootings by unauthorized users. Gun safety technology includes personalized guns, but also accessories like safes, locks, and retrofit kits that similarly help keep firearms secure. It could also include mechanical innovations that exclude child access more effectively than existing trigger locks.

PERSONALIZED GUNS

Personalized guns, or smart guns, use technology to give owners the ability to control who may access and use their firearm. The methods used to give owners this type of control vary, with the most common methods being radio-frequency identification (RFID) technology, which uses radio waves to automatically identify objects, and biometric sensors, such as fingerprint readers.

Personalized guns are an immensely promising development for gun safety. The technology could transform gun ownership by helping mitigate some of the risks owners and their families face every day. For example, unlike traditional handguns, which can be fired by toddlers as young as two years old, personalized guns cannot be discharged by children. Personalized guns also cannot be used in a suicide by an unauthorized user, and they are rendered useless if stolen by an assailant.

A fully functional version of an RFID-equipped personalized shotgun was completed nearly 20 years ago and has been tested by police.

Some have used the palm-print scene from *Skyfall* to dismiss personalized guns as science fiction, available only in a distant future where humanity perfects the phasers from *Star Trek* that can be set to "stun." In reality, the technology needed to personalize firearms is basic and has been available for years. Many smartphones already use fingerprint sensors, though newer sensors exceed the speed and reliability of those currently used in phones.[79] And many reliable everyday devices—including car keys, building access cards, clothing security tags, and pet identification microchips—employ the same RFID technology that can be used to secure a gun.[80]

In fact, far from being science fiction, personalized guns have already been designed and built. One model, a personalized shotgun, is equipped with an RFID chip that fires only if the shooter wears a matching ring. A fully functional version of this shotgun was completed *nearly 20 years ago*. It has since passed a rigorous battery of durability tests and been tested by a dozen police departments.[81]

Once technologically advanced firearms enter the market, the gun industry will almost certainly regret its initial rejection of personalized guns as the stuff of fiction. In 1970, the inventor of the RFID chip showed his technology to General Motors, which dismissed the technology as "too Buck Rogers."[82] Today, RFID technology generates $6 billion in annual worldwide revenues,[83] and the auto industry has many applications for it, including in rental cars, toll payment systems, and key fobs.

PERSONALIZED ACCESSORIES

Personalized accessories would add an extra layer of security beyond a traditional gun safe or locking device. Even if a gun is stored with a conventional lock and key, there is still a danger that children, teens, or other unauthorized users will find the key or break the lock—with tragic results. Think of Alicia, the 12-year-old girl who killed herself after picking a lock to the room where she knew her family members stored a

loaded gun. In Alicia's case, a locked door was not enough to prevent her from firing the gun, so an extra layer of security on the firearm itself could have saved her life.[84]

Gun safes and locks undoubtedly help secure firearms, but these devices have critical limitations. Traditional safes and locks are not always used properly, such as when owners keep the key close to the safe, in plain sight, or in another location children can find. Moreover, the locks themselves may be flimsy and easy to break. There are no current federal design standards governing firearm locking devices, and a number of gun locks have been recalled for failing to work as intended.[85]

Product designers have long recognized the opportunity to enhance the security of gun safes with fingerprint sensors or mechanical codes. These smart safes are harder to hack or crack than a typical lock and key, and versions that open with fingerprints have been sold for about 10 years and are widely available.[86]

In recent years, substantial progress has also been made to develop biometric trigger locks. One company, Sentinl, sells a portable lock, the Identilock, that fits directly over a handgun's trigger. The lock's fingerprint sensor is located where users' hands fall when picking up their gun. Once a print is recognized, the lock opens like a clamshell and drops off the weapon in a matter of milliseconds. Since June 2017, thousands of these biometric locks have been sold.[87]

Advanced safes and trigger locks like the Identilock may be poised to have an even wider impact than all-in-one personalized guns, given that hundreds of millions of traditional firearms are already in circulation in the United States. Personalized accessories could greatly improve the security of existing firearms without requiring consumers to purchase brand-new weapons.

WHAT TECHNOLOGY CAN MAKE GUNS SAFER?

The basic premise driving the development of personalized guns and accessories is the idea that technology can make firearms more secure, bring peace of mind to owners, and save lives. It's important to remember that the technology needed to do this is not light-years away from us. Rather, all that's required is pairing a firearm with *existing* security technology capable of identifying authorized users.

The two leading types of security technology, RFID chips and biometric sensors, are already in widespread use. RFID technology was invented in the 1970s and is used today in many car key fobs and building access cards.[88] Similarly, biometric fingerprint sensors are already used in gun safes and in smartphones, though fingerprint recognition technology has advanced since the version first included on the Apple iPhone. A smartphone is both more complicated and less dangerous than a gun, yet consumers have been able to secure their phones with fingerprints for years.

LESSONS FROM HISTORY: SEAT BELTS, MEDICINE CAPS, AND POWER WINDOWS

It is helpful to contextualize gun safety technology alongside other lifesaving innovations. This is not the first time that relatively simple design improvements, relying on established technology, were poised to transform a consumer product and save lives. It's actually a familiar pattern throughout history.

A BETTER SEAT BELT

One of the best-known examples of consumer safety innovation is the three-point seat belt, invented by a Volvo engineer in 1959. Existing seat belts, namely two-point lap belts, were ineffective at high speeds and failed to stop many deaths and injuries. In order to absorb force at high speeds, an engineer had the simple idea to combine a lap seat belt with a diagonal belt that fit across the wearer's chest.[89] This belt turned out to be incredibly effective and easy to use, increasing the likelihood people would wear it. Today, virtually every car uses three-point seat belts, and the invention is estimated to have saved more than one million lives, with likely many more people being protected against severe injury.[90]

SAFER MEDICINE BOTTLES

In the mid-20th century, drug companies saw an opportunity to change medicine packaging in order to prevent children from ingesting adults' prescription drugs, which can be lethal to kids even in low doses. The answer was the child-resistant cap, designed to only open with a pressing and twisting motion that is difficult for children to perform. Since its widespread adoption in the 1970s, the cap significantly reduced child prescription drug overdoses, cutting deaths by 45%.[91] The simple design is still familiar to the hundreds of millions of Americans who take prescription drugs today.

FIXING POWER WINDOWS

Another simple yet lifesaving development gained public attention in the early 2000s, when several young children were killed after getting their necks trapped in automatic car windows. These children had unintentionally raised the power windows in cars by pressing a button, known as a "rocker switch," without realizing it. In the mid-2000s, some carmakers adopted a straightforward fix to address these easily preventable deaths, replacing rocker switches with switches that must be pulled upward to close a window, which is harder to do unintentionally.[92]

SAFETY INNOVATIONS FROM OTHER INDUSTRIES

SEAT BELTS

Three-point seat belts **cut the risk of serious injury by 50%** and the risk of death by 45% among drivers and front-seat passengers.[v]

MEDICINE CAPS

The introduction of childproof medicine caps led to a **45% reduction in deaths** from prescription drug overdoses among children.[vi]

POWER WINDOWS

An improved switch design **prevented child suffocation deaths** caused by power windows in cars.[vii]

SIMPLE SOLUTIONS ARE IN REACH

Three-point seat belts, childproof medicine caps, and lift-up power window switches were relatively easy and inexpensive solutions to develop. All it took was manufacturers realizing that elements of their products were causing avoidable deaths and resolving to change this.

Gun safety technology falls into the same category of innovation. The advancements profiled in this report are not complex or prohibitively expensive. They rely on basic technology or, sometimes, mechanical design changes. The two most common means of making a gun personalized—RFID and biometric recognition—are not cutting-edge methods, but tried-and-true technology that's been around for decades, and the cost of implementing these features is only falling the older the technology gets.

HOW CAN GUN SAFETY TECHNOLOGY SAVE LIVES?

This report identifies opportunities for companies to pursue the same sort of technological innovation that has characterized the development of safer products throughout history. But this is not just innovation for innovation's sake. It's essential not to lose sight of the human dimension—the reason these specific advancements are needed and why they show such promise for saving lives.

PREVENTING SUICIDE

Timothy Daniel, who went by Timmy, was a 17-year-old student from Palm Coast, Florida. He was close with his mother, who once posted on her son's Facebook page, "My children may not have everything they want in life, but they have a mom who loves them more than anything in the world."[93] Timmy had been experiencing symptoms of depression and had previously been hospitalized.[94] Unfortunately, this treatment didn't save his life, and in July 2017, his devastated mother found Timmy's body lying in his bedroom. The 17-year-old had taken his own life with a .22 caliber revolver. The revolver had been stored with a trigger lock, but before he killed himself, Timmy used a saw to cut through the lock.[95]

Firearms belonging to a family member are by far the most lethal suicide method available to most young people, given that guns are fatal 84% of the time.

Suicides of teens like Timmy can sometimes seem like random, senseless tragedies. But research actually helps us understand exactly how these tragedies occur—and how we can prevent them. Most suicides, but particularly suicides by children and

teenagers, are impulsive acts.[96] Research shows that teens often plan their suicides in under *five minutes*.[97] Even when suicides are precipitated by depression or other signs of mental illness, the decision to actually go through with it and determine the steps necessary to end their lives typically occurs during a much shorter period of time.[98]

Therefore, a fleeting suicidal urge is often only carried out when it coincides with easy, immediate access to the tools needed to attempt suicide. Firearms belonging to a family member are by far the most lethal suicide method available to most young people, given that guns are fatal 84% of the time.[99] For this reason, guns are used in nearly half of all teen suicides.[100]

The impulsive nature of youth suicide and the unique lethality of guns means that if suicidal minors are unable to access or fire a gun, there is a high likelihood they will not attempt suicide again. In fact, most people who survive a suicide attempt do not go on to die by suicide.[101] In the case of young people in crisis, like Timmy, gun safety technology could mean the difference between life and death.

THE TRUE TOLL OF GUN SUICIDES

One might think the tragedy of a child's or teen's suicide is rare. In reality, gun suicide is the third-leading cause of injury death for Americans aged 10 to 14, as well as for Americans aged 15 to 19.[102]

The youth suicide rate has risen dramatically in recent years. CDC data shows that gun suicides by minors over 10 years old increased by 60% from 2007 to 2014.[103] Rising teen suicide rates have been linked to the fact that depression and other mental illnesses

SUICIDE RATES ARE RISING ACROSS THE COUNTRY

SUICIDE ATTEMPTS ARE OFTEN IMPULSIVE

71% of people attempt **within an hour** of making the decision.

48% of people attempt **within 10 minutes.**

PREVENTING GUN SUICIDE

Learn more in Giffords Law Center's report *Confronting the Inevitability Myth: How Data-Driven Policies Save Lives from Suicide*
giffordslawcenter.org/suicide

emerge before age 24, and young people can struggle with impulse control, emotional regulation, and stress management.[104]

When factoring in adult suicides as well, it becomes clear that suicide affects a staggering number of American families. From 2000 to 2015, suicide claimed over 575,000 lives, with more than half of those people—nearly 300,000—dying from self-inflicted gunshots.[105] Of these deaths, 17,000 were children who killed themselves before their 18th birthday, including 7,000 who used a gun.[106]

From 2000 to 2015, suicide claimed over 575,000 lives, with more than half—nearly 300,000—dying from self-inflicted gunshots.

This staggering loss of life during just 15 years, especially of young people with their entire lives ahead of them, is heartbreaking. It is past time to devote more resources to addressing suicide, particularly gun suicide, given the role firearms play in America's suicide rates. But all too often, misconceptions and stigma around mental illness keep our nation from understanding and confronting its suicide epidemic. As a result, too many people falsely believe that suicides are rare anomalies that we are powerless to prevent.

The reality is very different. Rising rates of depression and suicide may be a modern problem, but there are modern solutions within reach, including gun safety technology like personalized handguns, safes, and trigger locks.

PREVENTING SUICIDE IS POSSIBLE

Solutions that prevent suicidal people from accessing guns show so much promise because the consensus among experts is that suicide is not inevitable. To the contrary, suicidal people who live through one attempt have a 90% chance of not going on to die by suicide.[107]

While some suicidal teens or adults who are unable to access a gun may try to kill themselves by other means, the most common alternative methods of suicide are far less lethal, so more survivable, than suicide by firearm. Suicide attempters die 84% of the time when a gun is used,[108] while suicide attempts by drug overdose have only a 2.5% fatality rate, jumping has a 20% fatality rate, and self-inflicted cutting has a less than 1% fatality rate.[109] The bottom line: a suicide prevented by removing access to a gun may be a life saved.

PERSONALIZED GUNS AND SUICIDE PREVENTION

Personalized guns and accessories can potentially stop many self-inflicted gun injuries and deaths, particularly among children. As the American Academy of Pediatrics has repeatedly affirmed, "adolescent suicide risk is strongly associated with firearm availability,"[110] meaning that if a firearm is not readily available, many

children and teens would overcome their temporary impulse to attempt suicide.[111] Many youth suicides are carried out with a family member, relative, or friend's gun, as these are by far the most lethal weapons that suicidal children and teens can obtain.[112]

For these reasons, minors' access to unsecured guns is associated with higher rates of suicide.[113] But some suicides occur when a teen is able to break a lock and use a firearm that has been minimally secured. That's how Jack, a 17-year-old from New Jersey, got hold of a gun his father kept in a locked closet and used it to shoot himself. Jack's father stated that he went to "great lengths" to hide the keys to that closet, but still, Jack found the keys and fired the bullet that ended his life.[114] If adult gun owners could use technology to provide an *extra* layer of security beyond a conventional lock, many similar youth suicides could be prevented each year.

Gun owners could also use safety technology to limit access by adults who have expressed depressive or suicidal thoughts. Most people who attempt suicide are grappling with an impairing mental illness, like depression or PTSD, and exhibit or communicate warning signs leading up to a suicide attempt.[115] In fact, about 80% of people considering suicide give a sign of their intentions in advance.[116] This creates a window of opportunity to revoke authorization for an adult relative who normally has access to a firearm, potentially saving thousands of lives from suicide annually.

By allowing owners to limit access to their gun to specific authorized users—and take away access when necessary—gun safety technology gives families a powerful new tool to protect loved ones experiencing a mental health crisis. The result? Fewer suicide deaths, particularly among children and teens.

PROTECTING KIDS FROM UNINTENTIONAL SHOOTINGS

Too often stories about unintentional shootings by children make headlines: a three-year-old killing his mother in Walmart, a brother killing his sister with a rifle, a preteen injuring himself with a handgun. The examples are many, but the point is the same: when kids get access to unsecured firearms, tragedy follows.

One of the young victims of such a tragedy was Nicholas, a 12-year-old in Saratoga Springs, New York, who was unintentionally shot and killed by a friend his age. After his death, Nicholas's mother heard from

SAFETY RISKS TECHNOLOGY COULD SOLVE

4.6 MILLION

children live in homes with at least one unlocked and loaded firearm. It's imperative that all parents securely store guns around kids—and gun safety technology can help.[viii]

21,000

people die each year from self-inflicted gunshots. 80% of suicidal people show warning signs, so personalized guns can prevent suicide by teens and adults in crisis.[ix]

500,000

firearms are stolen each year in 350,000 incidents of theft. All gun owners at risk of theft could benefit from technology that blocks thieves from committing an assault.[x]

grieving families who remembered Nicholas as the boy who defended classmates who were being bullied at school.[117] Nicholas's family didn't own guns, but Nicholas went over to play at a friend's house, and the friend found his father's loaded handgun in a drawer and discharged it. The shot killed Nicholas, tragically cutting short the life of a boy who had already done so much to help others. Nicholas's parents only learned there was an unsecured firearm in the friend's home after it was too late to save their son.[118]

Because gun ownership is more prevalent in the US than its peer nations, American kids are 16 times more likely to die in unintentional shootings than children in other high-income countries.[119] American toddlers—children under age four—are involved in unintentional shootings about once a week.[120] Even children whose parents do not keep guns in the home are at risk. The proliferation of guns in US households makes it likely that a friend or neighbor, who may be hosting a playdate for other children, could have a loaded firearm.

Tragic unintentional shootings involving children share one common feature: a child gaining access to an adult's gun. For this reason, unintentional shootings involving kids are highly preventable if adults are able to completely secure their firearms from child access. It's easy to see how 12-year-old Nicholas's death could have been prevented if his friend's father's loaded gun had been equipped with a fingerprint reader or RFID chip that blocked the boy from being able to fire it.

While gun owners are supposed to take precautions to prevent children from using firearms, unsecured guns still endanger far too many American kids. One risk that has proven hard to mitigate is that gun owners may choose to keep one loaded firearm where they can access it quickly in the event of a sudden threat. But this habit means that millions of children live in houses with firearms easily accessible to them. A 2018 study found that an astonishing 4.6 million American minors live in homes with at least one loaded, unlocked firearm.[121] These millions of kids are at serious risk of harming themselves or others should they come across the loaded household gun.

American toddlers—children under four—are involved in unintentional shootings about once a week.

Research also shows that kids are curious about firearms, know the location of parents' guns, and are not capable of following instructions not to play with guns. One study that interviewed rural Alabama families revealed that nearly three-quarters (73%) of the children under age 10 who live in homes with guns said they knew the location of their parents' firearms, and 36% of these kids said they had actually

handled a household gun.[122] These statements contradicted 39% of the parents who said their children did not know where guns were stored and 22% of the parents who claimed their children had never handled a household gun.[123] The researchers observed the same "discordance between parent and child reports" even in instances where parents locked up their guns or discussed firearm safety with their kids.[124]

In other words, it is common for parents to *believe* their kids do not know the location of a gun or will obey instructions not to look for it—but all too often, these beliefs are dangerously wrong. One Harvard public health researcher explained it like this: "Your kid knows where the Christmas presents are. Your kid knows where the gun is."[125]

One Harvard public health researcher explained it like this: "Your kid knows where the Christmas presents are. Your kid knows where the gun is."

Kids who know where a household gun is may be tempted to play with it. The NBC program *Dateline* once interviewed parents who said they had taught their kids about the dangers of firearms and warned them never to touch one.[126] The parents were absolutely certain their children knew not to handle a gun for any reason. The *Dateline* interviewers had the parents watch from behind a screen while their kids sat in the same room as an unloaded gun. Child after child began playing with the gun, to the shock and horror of their parents.[127] Describing the *Dateline* footage in a separate interview, the chief criminal prosecutor of Wayne County, Michigan, observed:

"All of these children, who the parents had just insisted would never touch a gun, picked it up and starting playing with it. The allure was just palpable. I've never forgotten it."[128]

The *Dateline* investigation and other research discussed above shows that firearms can be an irresistible danger to children. Personalized gun technology offers a lifesaving solution for families like those interviewed for *Dateline*. If widely adopted, gun safety technology could protect many families from experiencing the tragedy caused when a child unintentionally shoots a household firearm.

GUARDING AGAINST GUN THEFT

Firearms are an expensive purchase for most people. Many new handguns retail for $350 to $500, while rifles and shotguns cost about $500 to $1,000, and pricier versions of all these can exceed $1,000 or $2,000. Guns are also easy to resell, particularly in states with lax or nonexistent regulations on selling guns online, at gun shows, or in private sales.

All this makes firearms an attractive target for thieves and gun traffickers. Data from the National Crime Victimization Survey (NCVS) shows that each year private citizens experience around 350,000 firearm thefts, accounting for 500,000 total firearms stolen.[129] The majority of firearms stolen are handguns.[130] Depending on their quality, stolen handguns can be resold on the black market for up to two to three times the initial retail price.[131] In recent years, many gun crimes have been linked back to firearms stolen from vehicles, where owners may leave handguns in a trunk or glove compartment,[132] and police officers believe guns stolen during car break-ins have armed many dangerous criminal offenders.[133]

ATF data shows that about 10–15% of stolen guns are later used in crimes, which, based on the above figures, includes thousands to tens of thousands of handguns per year.[134] If personalized guns were stolen during a burglary instead of traditional ones, fewer crimes could be committed following these thefts. A personalized gun could not be used in an immediate assault against the owner and would be less useful to thieves not capable of re-engineering and reselling the weapon. Similarly, if people had the means to store their firearm securely inside vehicles in a safe that couldn't be broken by force, fewer criminals would be able to arm themselves with guns stolen from cars.

Studies show that a gun kept in the home is more likely to be used in a criminal assault, unintentional shooting, or suicide attempt than it is to be used by the owner in self-defense.[135] And the dangers of a criminal assault are heightened in public spaces, where wielding a firearm against someone attempting to commit a crime runs the risk that the perpetrator will wrest the gun away and use it against the owner. Research shows that carrying a gun significantly increases a person's risk of being shot in an assault: even after accounting for other factors, individuals in possession of a firearm were about 4.5 times more likely to be shot in an assault than those not in possession.[136] Therefore, another way gun safety technology could save lives is by stopping assaults and other crimes from being committed with the 500,000 firearms stolen from private individuals each year.

ATF data shows that about 10–15% of stolen guns are later used in crimes—that's tens of thousands of handguns per year.

SECURITY FOR LAW ENFORCEMENT OFFICERS

Mitigating the risk that an assault will be committed with a stolen gun is likely to be particularly important for law enforcement officers. In 2014, 13% of officers killed in the line of duty had their weapons stolen by their attacker.[137] On a daily basis, police face the risk that a determined assailant will be able to take their gun and

use it against them or innocent bystanders. The risk is heightened for undercover and plainclothes officers, who typically have to use discreet holsters that are not as secure as the ones uniformed officers use, making their weapons easier to steal.[138]

Law enforcement officers also may need to store firearms in vehicles, leaving them vulnerable to theft. Recently in the San Francisco Bay Area, two high-profile killings were committed using firearms stolen from law enforcement vehicles. In July 2015, a man with prior felony convictions obtained a gun that had been stolen from a federal agent's car several days earlier, which he then fired on a crowded pier, killing 32-year-old Kate Steinle while she walked along the waterfront with her father.[139] Her last words were "Help me, Dad."[140] In September 2015, thieves stole a firearm by smashing the window of a car being used by federal immigration officers. The gun was used two weeks later to murder a 27-year old artist, Antonio Ramos, as he was standing outside in Oakland painting an anti-violence mural.[141]

Federal law enforcement agencies have long recognized that officers can reap huge benefits from using personalized guns in the line of duty.

Following these incidents, and several other publicized gun thefts from law enforcement vehicles,[142] San Francisco's police chief at the time offered to test personalized guns once the technology is adapted for law enforcement use.[143] The chief observed that the technology would give officers the immediate advantage of being able to "brick" a stolen gun—and render it unusable—the same way people can "brick" a stolen smartphone.[144] Like the technology behind smartphones, in the short term, personalization technology could prevent stolen guns from being used by the thief in the moments after they are stolen. In the long term, technology could deter criminals from stealing a gun in the first place, reducing gun trafficking and violence.

Federal law enforcement agencies have long recognized that officers can reap huge benefits from using personalized guns in the line of duty. In 1996 and again in 2001, the federal government issued reports recommending that safety technology be developed for law enforcement applications due to its potential to protect officers during "gun-grab" situations.[145] In 2016, acting on an executive order from President Obama, the National Institute of Justice met with law enforcement stakeholders to develop baseline specifications for gun safety technology that could be used by police forces. The final specifications detailed operational requirements for law enforcement firearms equipped with safety technology and could be used to guide development of personalized guns for law enforcement officers.[146]

LIFESAVING TECHNOLOGY ALREADY EXISTS

The technology to save lives from gun violence is out there—now it's just a matter of overcoming the gun lobby's resistance.

Entrepreneurs have already used some types of user-recognition technology, including RFID chips and fingerprint sensors, to build safer, personalized guns and locking accessories. Understanding the lifesaving work that has been done—and what's left to do—requires a deeper exploration of the following: (1) how gun safety technology works, (2) which entrepreneurs have already developed and sold safer guns and accessories, and (3) the challenges gun safety developers have faced in readying their products for the market.

FIREARMS AND USER-RECOGNITION TECHNOLOGY

At the outset, it's important to understand the fundamentals of how gun safety technology can make firearms more secure. Personalized guns prevent access by unauthorized users by physically blocking the gun from firing unless an authorized user is recognized. There are several ways to block a gun from firing, including internal motors and other electrical devices that respond to a signal communicating whether a user is authorized.[147] Similarly, there are several methods to *unblock* a gun by sending a signal that a user is recognized. These latter methods can also be used to allow access to a personalized accessory, such as a gun safe or lock.

The two main mechanisms used to activate a firearm or an accessory when an authorized user is recognized are **biometric recognition technology** and **token-based technology**. Within the major categories of biometrics and tokens, a number of different applications have been developed. Each application has different benefits and could be useful for different types of firearm users.

BIOMETRICS—BUILT-IN

Biometric technology uses individuals' biological features, such as a fingerprint, palm print, or grip, to identify authorized users. Biometric firearms use electronic sensors that are part of the gun's design to detect a user's biometric feature and compare it to stored profiles. For instance, a **fingerprint sensor** could be placed in the spot where a user's hand will naturally fit. The sensor scans the user's print, compares it to stored prints, and unlocks the gun for use if there is a match within a set tolerance.

Common fingerprint sensor technologies use conductor plates that perform capacitance imaging, which measures the distances between fingerprint ridges and grooves.[148] Using the latest hardware and imaging algorithms, sensors can authenticate users in a fraction of one second. Some advanced fingerprint scanners report false negative authentication rates as low as 0.01% (one in 10,000),[149] much lower than the rate of expected mechanical malfunctions in traditional firearms.[150]

Some advanced fingerprint scanners report false negative authentication rates as low as 0.01%, much lower than mechanical malfunctions in traditional firearms.

Biometric sensors that employ **dynamic grip recognition** could also be placed where a user will naturally hold their firearm. Dynamic grip recognition, a technology developed by the New Jersey Institute of Technology (NJIT), works by analyzing physical behaviors that have been found to be unique and detectable every time a person grips a firearm and pulls the trigger. These behaviors include hand size, shape, grasping strength, and pressure applied by various parts of the hand. These attributes of a person's grip can be used to build a profile that accurately identifies the person who grips a firearm within a tenth of a second as the trigger is pulled.[151]

Innovators at NJIT pioneered a dynamic grip recognition system that could measure hand shape and the pressure pattern applied to a handgun.[152] Testing showed that the pressure pattern was "individual to the user, reproducible, and measurable."[153] The dynamic grip recognition technology developed at NJIT was capable of detecting grip patterns and unlocking the firearm as the trigger was being pulled "with no apparent lag to the shooter."[154] Unfortunately, the institute ran out of funding for the project and had to shelve its dynamic grip recognition system.[155]

BIOMETRICS—EXTERNAL SAFE OR LOCKING DEVICE

Another potential use for biometric recognition technology is in firearm storage accessories. Traditional firearms already in circulation can be made safer if they are stored in a fingerprint-locked gun safe or equipped with a biometric trigger lock.

Personalized accessories have significant advantages over traditional gun safes and locking devices, which don't always function as intended and can sometimes be easily unlocked, picked, or broken. Troublingly, there are no federal laws setting design safety standards for firearm locking devices, and some gun locks have had to be recalled.[156] Moreover, safes and locks are not always properly used. Firearm owners who store a loaded weapon in a locked cabinet, room, or drawer may keep a key nearby, in case they need to access their weapon quickly. But that means a child or teen could find the key and use it, with tragic results.

Alexis Wiederholt of Missouri experienced this type of tragedy. Alexis lost her nine-month-old son, Corbin, when another one of her sons, who was just five, broke into a gun cabinet in his grandfather's bedroom. Although the cabinet was locked, it apparently could be opened with many different implements, including a screwdriver or other keys. The cabinet contained a loaded gun Alexis didn't know her father kept in his house. The boys' grieving grandfather later explained that he told his grandsons that "they weren't supposed to be in my bedroom where I keep the gun cabinet and they knew it."[157] Still, Alexis's five-year-old was able to open the locked cabinet and shoot his infant brother.

Biometric safes and locks provide an extra layer of security because they do not require owners to use only a physical key, which a child could find. Advanced safes and locks can also potentially be opened faster by an authorized user. Traditional safes take at minimum a few seconds to open with a key or combination,[158] but proposed new designs for biometric safes that rely on intuitive placement for fingerprint sensors may be unlocked even faster—in about half a second.[159] The Identilock, a biometric trigger lock currently being sold online and in brick-and-mortar stores, can be opened in about 3/10 of a second.[160]

SAVING LIVES THROUGH FIREARM DESIGN

Diverse designs for gun safety technology may be useful in different situations. For example:

RFID TOKENS

RFID tokens activate a firearm when they are in close proximity to it. A gun paired with an RFID ring may be ideal for police officers trying to prevent gun grabs.

ADVANCED FINGERPRINT SCANNERS

Advanced fingerprint scanners could work well for a weapon kept at home. Scanners are being designed to activate quickly for authorized owners but reliably prevent kids from gaining access.

BIOMETRIC—COMBINATION

Multiple biometric methods could be combined in order to improve the reliability of the identification system. For instance, a fingerprint reader that has a 1-in-10,000 failure rate could be combined with another method, like a palm print reader with a failure rate of 1-in-1,000, for a combined failure rate of 1-in-10,000,000.[161] A fingerprint reader's baseline failure rate of 1-in-10,000 is already lower than the mechanical failure rates of a traditional firearm,[162] but combining two or even three biometric methods could make these guns even more reliable.

Personalized guns or accessories with biometric recognition features could also be equipped with a mechanical backup, like a key or a security code. Including a backup key or code would not necessarily undermine the enhanced security of a biometric gun or accessory. Unlike with traditional gun safes or trigger locks, the owner could use the key as a true backup, making sure the key itself is securely stored.

TOKEN-BASED TECHNOLOGY—FIREARMS AND ACCESSORIES

Token-based recognition technology requires firearm owners to use an additional item, like a ring, watch, or other accessory, to access their gun. These accessories, often called "tokens," contain a chip that transmits a coded identifying signal that is received by a firearm with a corresponding signal detector. The chip could also transmit an identifying signal to an RFID safe instead of to the firearm itself.

The most common type of signal used for this purpose is short-range **radio-frequency identification (RFID).**[163] When the RFID signal—transmitted from a ring, watch, or other accessory—is brought within a certain distance of the corresponding firearm, the firearm will detect the token and allow the gun to be fired.[164] An RFID safe would work the same way: within a set distance, the safe would detect the authorized user's token and "unblock" its locking mechanism.

A personalized gun equipped with an RFID chip reader could be activated using a ring, bracelet, or badge with a corresponding RFID chip.

Token-based technology works like an electronic key card: the token is a physical object, but unlocks items using an identifying signal. For example, a personalized gun equipped with an RFID chip reader could be activated using a ring, bracelet, or badge embedded with a corresponding RFID chip. When the owner holds the token close enough to transmit the RFID signal, such as within 1–2 inches, the personalized gun will release a blocking mechanism, allowing it to fire.

RFID tokens are not barcodes and do not need to be positioned in a special way to activate the signal detector: close proximity is all that's required.[165] The RFID system could be designed so that the signal detector is automatically in close enough proximity to the token when the owner picks up a gun, such as by embedding an RFID token in a ring worn on the owner's dominant hand. This type of system, dependent on close proximity—within inches—between the chip and the firearm or safe, has many advantages. For example, if an assailant were to grab a personalized gun from its owner, the required close proximity would be lost and the gun would stay locked, unable to fire.

Short-range RFID chips—also called passive RFID chips—do not require use of a battery, because they are powered by electromagnetic induction (though the gun or safe's blocking mechanism may be battery powered).[166] RFID chips are not affected by rain or mud, and can be worn under gloves, making them ideal for police officers, who could incorporate a ring or bracelet under their gloves as part of their uniform.

TOKEN-BASED TECHNOLOGY—IMPLANTS

At least one innovator has designed a personalized gun that can be activated with a tiny RFID implant—the size of a grain of rice—placed inside the user's hand.[167] Hand implants are rare, but may become more common in the future. One Wisconsin company recently gave its employees the option to receive an RFID implant that they could use to open doors, log in to computers, and pay for items. The implant was voluntary, and could only include information employees chose to associate with it.[168] The company reported high demand for and satisfaction with the implant.[169] While any implant raises privacy and medical ethics concerns, RFID implants have been approved by the FDA for over 13 years, and RFID chips do not include GPS or tracking mechanisms that raise privacy concerns. Someday, safe body implants may be more common among police officers or certain members of the public, and it may be convenient to use existing body implants to activate a personalized gun.

NUMERICAL OR TACTILE CODES

Another user-recognition feature that could be employed in a firearm is a numerical or physical code or combination. For example, biometric or RFID recognition features could be paired with a security device that requires entry of a personal identification number (PIN) to unlock the gun, either as a backup or as an extra layer of security known as two-factor authentication.[170]

A security code does not need to be numerical. One existing mechanical firearm lock uses a combination dial that listens for a specified number of audible "clicks" rather than reading numbers. This means the dial can be started from any point or orientation and be unlocked in the dark.[171] The lock was developed in Israel and is now

HOW GUN SAFETY TECHNOLOGY WORKS

TOKEN-BASED TECHNOLOGY

Uses an accessory, or "token," that transmits a coded identifying signal to the owner's firearm.

Gun remains locked without token.

Firearm user wears a token—such as an RFID watch or ring.

The gun unlocks when the user brings the token into close proximity.

BIOMETRIC TECHNOLOGY

Uses individuals' biological features, such as fingerprints, palm prints, or grips, to identify authorized users.

Gun remains locked without pre-authorized user.

A pre-authorized user picks up the gun.

The gun unlocks after recognizing the user's biometric feature.

FINGERPRINT SAFE

An example of biometric technology, these gun safes can be unlocked with authorized users' fingerprints.

Gun is kept in a biometric safe that stores fingerprints.

A pre-authorized user unlocks the safe with their fingerprint.

The safe opens after recognizing the user's print.

FINGERPRINT TRIGGER LOCK

Another example of biometric technology, this trigger lock can be unlocked with authorized users' fingerprints.

A hard clamshell lock is secured around a gun's trigger.

A pre-authorized user opens the lock with their fingerprint.

The lock drops off the gun after recognizing the user's print.

sold online to US customers.[172] Another inventor has proposed building a keyless lock that uses a "tactile" code that can be entered with users' fingers to unlock a gun's firing chamber.[173] Users would depress and raise their fingers in a pattern they select to unlock the gun. Over 100,000 possible unlocking combinations could be chosen based on users' five fingers, and the combination could be entered quickly and in darkness.[174]

GUN SAFETY TECHNOLOGY CURRENTLY ON THE MARKET

Given how successfully other consumer products have incorporated RFID chips and fingerprint sensors, it's far from a leap to think that the same technology would work well in firearms, safes, and locking devices. Of course, when it comes to firearms, the potential benefits are enormous—likely much greater than with other types of products. Using advanced technology to secure firearms could:

- **Protect the 4.6 million kids living in homes with an accessible loaded gun.**
- **Reduce the number of gun suicides—currently about 21,000 annually.**
- **Prevent gun thefts and stop assaults from being committed with some of the 500,000 firearms stolen every year.**

The exciting news is that much of the groundwork for innovation has already taken place, thanks to bold efforts of first movers in the market. The safety technology discussed above has already been successfully deployed in gun safes and a lock currently on the market and, in one instance, an all-in-one firearm.

PERSONALIZED ACCESSORIES HAVE GAINED A MARKET FOOTHOLD

At least a half-dozen companies currently sell biometric gun safes, several sell RFID safes, and one sells a biometric smart-lock. The presence of these personalized accessories on the market is a significant marker of progress in the evolution of gun safety technology.

BIOMETRIC GUN SAFES

A number of companies sell gun safes that can be opened with stored fingerprints, usually with a physical key as a backup. For example, GunVault sells a biometric safe that stores up to 30 fingerprints. According to the company, whenever the safe is opened, the sensor "adds new information to the fingerprint templates. It also updates slight changes that might occur over time to an enrolled fingerprint as well as helps distinguish variations between enrolled fingerprints."[175] Other companies selling biometric safes include Vaultek,[176] GunBox,[177] Sentry Safe,[178] Verifi,[179] and BARSKA.[180]

Customer reviews for these safes suggest that they are serving their intended purpose: to provide an added layer of security for firearm owners, particularly parents. Many reviewers report that they purchased the safe to protect children in their home. For instance, one reviewer of the GunVault notes the "sense of security that [the safe] gives us to know that our grandchildren cannot access our pistols."[181]

RFID SAFES

Several companies sell RFID safes that can be unlocked when a bracelet, key fob, or a wallet-sized card is waved in front of the safe. Some safes offer an RFID decal that can be attached to a different accessory of the owner's choice.

Companies selling RFID safes include Hornady Security Products,[182] GunBox,[183] and Winchester Safes.[184]

SENTINL IDENTILOCK—A BIOMETRIC TRIGGER LOCK

Sentinl, a Detroit company, developed, manufactured, and sells the Identilock, a portable, fingerprint-based lock that fits directly over the trigger of a firearm and works with a variety of handgun models.[185] The Identilock retails for $239 and is sold online and in Cabela's stores; sales have been brisk since the device first went on sale in June 2017.[186] The Identilock's inventor and Sentinl's founder, Omer Kiyani, is a father, engineer, and gun owner who has personal experience with firearm accidents: as a teenager, he was shot in the face with an unsecured gun.[187]

The Identilock's "clamshell"-style lock completely encases a handgun's trigger, making it inaccessible until the lock is opened.[188] When an authorized user picks up the handgun using a natural grip, the Identilock reads the shooter's fingerprint and then unlocks, dropping off the gun and exposing the trigger for firing.[189] Kiyani says he used the iPhone's fingerprint unlock time as a "benchmark" for how quickly his trigger lock should recognize a fingerprint and fall open, except his device uses a larger, more accurate sensor with technology that has been approved by the FBI, so may exceed the iPhone's response time.[190] The unlock time for the Identilock has been gauged at just 300 milliseconds, or 3/10 of one second.[191]

ALL-IN-ONE PERSONALIZED GUNS ARE BECOMING MARKET-READY

The Sentinl Identilock and the biometric and RFID gun safes discussed above show that personalized accessories have already reached the consumer market and are picking up momentum. The market for all-in-one personalized guns has not reached the same stage of development as accessories, with one exception.

COMPLEMENTING SAFE STORAGE

When the first seat belt laws were proposed, some objected that seat belts might actually increase traffic fatalities. The idea was that drivers wearing seat belts would drive more recklessly, causing more accidents.

This is called a "compensating effect." But years after seat belts became standard, researchers found that actually, seat belts did not encourage careless driving.[xi] The same should hold true for effective gun safety technology—like biometric trigger locks—designed to complement, but not replace, safe storage practices for firearms.

In 2006, a German company, Armatix, developed a "smart gun system," selling it in Europe and later pitching it to US retailers. The system is a pistol paired with a watch that uses an RFID transponder to identify authorized users within about 15 inches.[192] Because the Armatix smart gun system was invented over a decade ago, it does not reflect the major advances in user-recognition technology since 2006. The pistol is also a small caliber (.22), and Armatix's CEO explained that it "wasn't intended to be used for self-defense" and was merely a test vehicle for their technology or a "practice weapon."[193] No American retailer ended up stocking the Armatix system, and while it is offered for sale online, reports suggest the US volume of online sales is quite low.[194]

While Armatix made a bold effort to explore how technology can create a safer gun, the company's smart gun system is outdated and not representative of where gun safety technology is today. For instance, the system uses magnets in its locking mechanism, which other developers have avoided because of security vulnerabilities. In 2017, an anonymous hacker showed a *Wired* reporter that with cheap magnets and jamming technology, he could interfere with the Armatix pistol.[195] Some opponents of gun safety technology have cited this episode as a reason to stifle research and innovation into personalized guns, but the *Wired* story failed to mention that the Armatix pistol the hacker compromised was a decade-old .22 caliber "practice weapon" never intended for self-defense.

One hacker's ability to compromise an outdated weapon is not a reason to stop researching and developing this technology. In fact, it is the reason to support *more* research and development, in order to attain a robust market for "smart guns" that truly merit the title—firearms that incorporate reliable personalization technology and appeal broadly to consumers.

CHALLENGES AND OPPORTUNITIES FOR DEVELOPERS

Technology has advanced well beyond the Armatix pistol, yet the pistol's history is still instructive because of the extreme reaction gun lobby groups like the NRA had to Armatix's design. Although, as discussed above, the Armatix pistol was a low-caliber "practice weapon" not intended to replace traditional firearms, industry representatives made it a priority to block US retailers from even stocking it—and they succeeded.

This reflexive opposition reveals the gun lobby's extreme discomfort with technological progress and with the mere suggestion that guns could be made safer. Obstructionism like this poses a direct challenge to innovators seeking to bring safer

firearms and accessories to store shelves. But the situation is far from hopeless. The industry's reaction to the Armatix pistol also sheds light on how future developers might successfully crack the US market for gun safety technology.

GUN LOBBY INTERFERENCE

In 2014, as soon as the first US retailer expressed plans to stock the Armatix "smart gun system," stores faced immediate opposition from corporate gun lobby groups who claimed selling Armatix's product would trigger a New Jersey law known as the "smart gun mandate."[196] That law requires that only personalized handguns be sold in New Jersey sold two to three years after a qualifying personalized handgun is first sold somewhere in the country.[197] Citing this law, industry representatives and activists quickly coordinated efforts to boycott retailers that planned to sell the Armatix pistol. The boycotts gained momentum in the early months of 2014 and grew vicious and personal: one retailer received death threats, and an Armatix employee was stalked.[198]

The NRA's actions revealed that it would go to great lengths to block any technological advancement that could threaten business as usual.

Eventually, the two American retailers who had planned to sell the Armatix pistol backed down, citing the boycotts and intimidating personal attacks.[199] The vitriolic nature of the boycott campaign hearkened back to the NRA-led boycotts of Smith & Wesson in 2000, after the company settled litigation over its firearm designs by agreeing to develop personalized guns. The NRA's response to this agreement was to initiate a boycott campaign that nearly halved the company's revenues; Smith & Wesson was only narrowly able to avoid bankruptcy and backed out of the agreement.[200] The former CEO explained the fallout from the NRA boycott like this: "The message that was sent to the other gun manufacturers was that 'if you don't want to go through a really difficult time, stay away from it'"—meaning gun safety technology—"forever."[201]

In the more recent case of the Armatix pistol, the NRA argued that the New Jersey mandate motivated its boycotts. However, that argument turned out to be unfounded. In November 2014, the New Jersey Attorney General determined that Armatix's pistol did not fall within the state's definition of a smart handgun, so the mandate would not apply to its sales.[202] By boycotting Armatix *before* a decision was made about how it would be classified in New Jersey, the gun lobby tipped its hand. The NRA's actions revealed that it would go to great lengths to block any technological advancement that could threaten business as usual or undermine the group's obstructionist message that technology cannot be used to improve gun safety.

MANUFACTURER INACTION

Over the course of the last two decades, the major American gun manufacturers have avoided their responsibility to explore design safety improvements. This includes several manufacturers who chose not to pursue personalized gun projects even after they received government funding to research and develop safer guns.[203] Following the gun lobby's 2000 boycott of Smith & Wesson and its intense opposition to the Armatix pistol in 2014, major players in the gun industry have become further entrenched in their inaction.[204] Even as biometric recognition and RFID technology has steadily improved, gun manufacturers have continued business as usual—not only producing traditional firearms, but also directing resources to building hyper-dangerous accessories. None of that energy has been directed to designing a *safer* gun.

Why haven't any major manufacturers taken the opportunity to bring firearm designs into the 21st century? The answer likely has more to do with hardline opposition from gun lobby groups than intrinsic technical or resource limitations. It's easy to understand how the NRA's campaign to intimidate manufacturers and retailers into dropping plans to develop gun safety technology has forced more responsible members of the gun industry, like Smith & Wesson in 2000, to avoid exploring safer designs. As Smith & Wesson's former CEO predicted, manufacturers fearing the consequences of revenue-slashing boycotts have essentially ceded control of the issue of gun safety technology to the NRA,[205] which has continued to advance the convenient narrative that safer firearms are unattainable.[206]

Some observers have tried to raise other justifications for why manufacturers have uniformly failed to explore gun safety technology, such as the fact that guns are mechanical devices and it is infeasible to outfit them with electronics.[207] It is true that firearm manufacturers may lack general expertise with electronics, and that producing a successful personalized gun would likely require hiring outside contractors with electronics systems skills. **However, gun companies have already demonstrated that they possess the resources and technical capability to work with electronics—they've done just that to make guns more lethal and dangerous.**

In 2013, a start-up in Texas produced and started selling a "smart rifle," sold for up to $22,000, that contains a built-in laser range finder, a ballistics computer, and a Wi-Fi transmitter.[208] The weapon was developed over the course of three years by a team

HOLDING FAST TO OUTDATED FIREARM TECHNOLOGY

Basic firearm mechanics have not changed over the last century.[xii] Recent technological innovations have made guns more lethal—not safer.[xiii] Gun manufacturers continue to refuse to acknowledge the safety risks their products pose to vulnerable members of our population.

History has shown us that those who resist progress get left behind. Gun manufacturers turning their backs on safety technology run the risk of becoming as obsolete as the horse and buggy companies that failed to adapt to the introduction of the Ford Model T.

of 70 people, and its lasers and computers vastly improve shooting accuracy for long-range targets, even for novice shooters. Many believe this firearm is too dangerous to sell to civilians, in part because the gun "makes it too easy for a criminal or a terrorist to shoot people from a distance without being detected."[209] Nonetheless, Remington announced plans to incorporate the technology into a $5,000 rifle,[210] and many other manufacturers already produce laser scopes that are mounted on traditional weapons.[211]

There's no doubt manufacturers are capable of incorporating technology into guns, given that some have already done so to create more lethal firearms.

There's no doubt manufacturers are capable of incorporating technology into guns, given that some have already done so to create more lethal firearms.

There's no doubt that manufacturers are capable of incorporating technology into guns, given that some have already done so to create far more lethal firearms. The industry is also more than capable of marshaling the resources to develop and sell new products. But a progress-resistant mindset and the influence of the NRA has left most manufacturers unwilling to take any of these steps to use technology to save lives, rather than make it easier to end them.

LESSONS LEARNED FROM THE BOYCOTTS

The gun industry's extreme reaction to the Armatix pistol explains why now, in 2018, leadership in researching and developing gun safety technology is not coming from established US gun manufacturers. Rather, innovation is coming from start-ups and individual entrepreneurs, who are more willing to explore bold possibilities for designing safer firearms and accessories. With little support from the mainstream gun industry, these groups have already shown that lifesaving progress is possible. For example, Omer Kiyani's company, Sentinl, has already produced and sold thousands of units of the Identilock biometric trigger lock.

Though the NRA represents the interests of gun manufacturers as a group, it has isolated and retaliated against individual manufacturers who fail to toe the gun lobby line so much that traditional gunmakers feel it is too risky to develop safer firearms. Luckily, the NRA does not have that same power over smaller companies and entrepreneurs. In the words of a young founder of one personalized gun company, "I won't be able to work with a firearms manufacturer to develop the technology [because a] boycott could kill a big company.... But it's not going to do anything to a little start-up like me."[212] As the next section of this report will describe, with additional time and resources, new designs from "little start-ups" will be positioned to transform the market for gun safety technology—leaving the NRA behind.

PROFILES OF GUN SAFETY DESIGN INNOVATORS

Innovators have been on the job of designing safer guns and accessories for years now. Their progress is worth a close look, as it suggests where the market is likely headed.

As discussed previously, efforts to develop safety technology by big US gun manufacturers have stalled out. In the last 15 years, some manufacturers made preliminary efforts in this area and a few even accepted government grants for personalized gun projects. However, the manufacturers failed to deliver promised prototypes and all of them ended up tabling the projects. These big companies likely did not want to risk a fallout like the one Smith & Wesson faced when it agreed to improve firearm safety. As discussed above, that company was the target of boycotts that nearly drove it out of business.

Fortunately, start-ups and individual innovators have picked up where big manufacturers left off:

1. A wide array of designs is likely to expand consumer choice, thus saving more lives.
2. Smart guns are becoming "smarter"—faster, more reliable, and with better battery life.
3. Accessories, like safes and trigger locks, are also becoming "smarter," incorporating intuitive features to facilitate quick unlocking.

Ambitious entrepreneurs aren't merely creating variations of the same gun safety technology—they are carving out spaces of their own within the field. In some respects, the development of personalized accessories has advanced more quickly than the development of personalized guns, as products like biometric safes are already on the market, but progress in both areas is proceeding rapidly. In the coming years, the development of a range of personalized guns and accessories will likely expand consumer choice while tackling the problem of firearm accidents, suicides, and thefts from multiple angles.

BIOFIRE TECHNOLOGIES

FINGERPRINT HANDGUN

MIT student Kai Kloepfer first developed a personalized gun prototype for his high school science fair. Today, his company, Biofire Technologies, is developing a handgun that will unlock with a fingerprint sensor.

How It Works On Biofire's prototypes, the fingerprint sensor is the size of a dime and positioned where the shooter's middle finger naturally gets placed.[213] A *Wall Street Journal* reporter who tested the prototype explained the process as follows:

"What Biofire gets right is technology that's almost invisible to the user; anyone who knows how to fire a handgun and unlock an iPhone needs no special instruction. When you pick up the Biofire gun, it wakes up from a low-power mode and activates the microprocessor and sensor... Assuming your fingerprint is a match, the circuitry releases an internal trigger lock."[214]

Speed Biofire's prototype incorporates recent advancements in biometrics. Its fingerprint reader is manufactured by a Swedish company that supplied the Google Pixel smartphone.[215] The reader currently takes about a second and a half to recognize prints, but Kloepfer—who is finessing the recognition algorithm—projects he can reduce that to under half a second.[216]

Reliability Kloepfer measures the accuracy of his fingerprint sensor at 99.999%. If true, the sensor will be more reliable than the firearm's mechanical components.[217] Biofire's technology isn't easily sabotaged because it cannot be accessed without fully taking the firearm apart, and the gun will not connect to the internet or send signals capable of enabling remote control. Since the firearm uses biometrics for a "single purpose application," Kloepfer says it is about as hackable as a toaster.[218]

Battery Life The gun can be charged through a USB plug in the grip and will take one hour to fully charge. The charge lasts for over a year.[219]

Who Can Use It The Biofire gun would be well-suited for home use. Environmental conditions might interfere with the fingerprint reader, but Biofire's prototype deals fairly well with wet hands; water just needs to be quickly wiped off before the fingerprint sensor will work.[220]

What's Next Kloepfer is fundraising with the goal of building a prototype from scratch, completing further design testing, and eventually manufacturing and selling the Biofire gun.

iGUN TECHNOLOGY

RFID SHOTGUN AND HANDGUN

Jonathan Mossberg is the former president of UZI America and former head of manufacturing for America's oldest family-owned gun company, OF Mossberg & Sons (founded by Mossberg's great-grandfather). In 1998, Mossberg conceived and built the iGun, the first truly personalized gun: a shotgun that employs RFID token technology to limit access to authorized users.[221] Mossberg did not merely build a prototype, but a fully functioning firearm that successfully passed Mil-SPEC testing, the US military standards to ensure that a rugged device functions properly in extreme environmental conditions.[222] Since 1998, Mossberg has been fundraising to be able to bring his game-changing technology to handguns.

How It Works The iGun shotgun is activated by a ring with a passive RFID chip in it. The chip, which is the size of a grain of rice, uses a low magnetic frequency that transmits only a short distance. This means the ring must be worn on the hand gripping the shotgun. Once someone wearing the ring picks it up, motors automatically unlock the shotgun's trigger.[223] The system turns off when the grip on the firearm is loosened, or the ring moves about two inches away from the stock.[224]

Reliability Mossberg explains that the iGun shotgun is a "dumb smart gun," in that it doesn't contain electronics that could be remotely disabled or magnets that could be interfered with. The RFID chip simply makes it so the gun is awake if it is close enough to the corresponding token or asleep if it is more than two inches away.

Speed Experts from the National Institute of Justice (NIJ) determined that it takes less than "0.25 seconds" for the iGun shotgun to recognize authorized users: it "works as soon as handled."[225]

Battery Life The ring contains a waterproof replaceable battery.[226] Though the battery was designed to last for 10 years, in 2013, the NIJ reported that iGun shotguns built before 2000 with the 10-year battery were still functional 13 years later.[227]

Safety Benefits A handgun using the iGun's technology would be particularly useful to law enforcement officers who want to make sure their weapon cannot be used against them if taken away during a struggle with a suspect. The iGun shotgun has successfully completed

tests intended for law enforcement service weapons,[228] and as of 2016, more than 12 police departments had tested the iGun, including in Connecticut, New York, New Jersey, and Florida.[229]

What's Next The iGun shotgun is production-ready.[230] But instead of marketing the shotgun version, Mossberg wants to raise money and then bring his technology to handguns, the far bigger market. He estimates that process will cost him an additional $5 to $20 million.

SENTINL
FINGERPRINT TRIGGER LOCK

Identilock, designed and manufactured by Sentinl, is a biometric trigger lock that completely encases a handgun's trigger until the lock recognizes an authorized user. The Identilock retails for $239 and is sold online and in Cabela's stores. Thousands of units have been sold since July 2017.[231]

How It Works When an authorized user picks up their handgun using a natural grip, the Identilock reads the shooter's fingerprint then unlocks, dropping off the gun and exposing the trigger for firing. The device also includes a backup key.

Speed The Identilock's unlock time has been measured at 3/10 of a second. The device can also be locked quickly onto a handgun, which Sentinl's founder describes as "the real innovation" because conventional trigger locks aren't as easy to affix to a gun.

Safety Benefits The Identilock improves the security of a mechanical trigger lock and could be an ideal solution for parents seeking to ensure that a child or teen cannot access their firearm.

What's Next Sentinl received venture capital funding and a grant from the Smart Tech Challenges Foundation to test and manufacture the Identilock. The company plans to use recent funding to expand the device to fit more gun models.

VARA

BIOMETRIC SAFE/HOLSTER

Reach, designed by a start-up called Vara, is a biometric safe designed like a gun holster in order to allow one-handed access to the firearm in under half a second. Vara's founder collected feedback from 1,500 gun owners to create his hybrid design between a safe and a holster.

How It Works Reach facilitates fast unlocking with an intuitively placed fingerprint reader that unlocks the safe while the user's hand arranges itself into a natural shooting grip.[232] Since operation is one-handed, the safe makes it easier to react instantly in an emergency.[233]

Speed Reach is designed to open in under half a second, using a locking system that retracts in milliseconds and a fast fingerprint processing mechanism.[234]

Where to Use It Reach's design integrates biometric technology (used in existing gun safes) with a holster-like design that allows for intuitive access. The safe can be attached to a bedside table or inside a car. The ideal user might be a parent or other gun owner who wants increased security for a stored weapon but also wants to retrieve it quickly.

Safety Benefits Reach's concept is designed to give people increased security while facilitating fast access. The beneficiaries? Families with young children or at-risk teens, people concerned about burglaries or car thefts, or anyone concerned about a suicidal relative.

What's Next Vara used a grant from the Smart Tech Challenges Foundation to build working prototypes, which have undergone user testing to finesse its intuitive features.[235] Later in 2018, Vara hopes to have a final product design and pilot its prototype for beta testing.

GUNGUARDIAN

RETROFIT TRIGGER GUARD

Rob Harvey and Will Murphy are veteran law enforcement officers who designed the GunGuardian, a durable mechanical trigger guard that can be retrofitted to traditional firearms.[236]

How It Works When the owner disengages the GunGuardian, the device retracts a spring-loaded shield that was covering a firearm's trigger, revealing it so the weapon can be fired (the GunGuardian itself remains attached to the firearm). Harvey and Murphy are currently developing several versions of the design, which differ in the mechanism used to unshield the trigger. The first, the TS1, would allow owners to uncover the trigger of their firearm by pressing a button. This would not prevent a child or unauthorized person from accessing a gun, but would reduce purely unintentional shootings by firearm owners. The second, the TS2, requires pressing two buttons simultaneously to retract the trigger shield, a "toddler-resistant" option that will reduce the likelihood a child can access the weapon. The third, the TS3, offers the additional layer of security of an integrated mechanical combination lock, with a possible expansion to include a biometric lock.

Who Can Use It The current iterations of the GunGuardian are retrofit kits intended to replace the factory grip of the AR-15. The GunGuardian attaches semi-permanently to the AR-15 using the same screw that attaches the factory grip.

Speed & Reliability Expert and blogger Mike Weisser ("Mike the Gun Guy") gave the GunGuardian a positive review, explaining that it replaces the factory grip without adding "any extra bulk or size," and "added hardly any time in moving the pistol from the 'ready' to the 'go.'"[237] Speaking to its reliability and ease of use, the reviewer deemed the GunGuardian "a safe gun device that does what it's supposed to do: make a gun safe."

Safety Benefits The device could reduce unintentional shootings both by toddlers in the home, and by adults at a gun range. High-visibility versions of all three models use reflective tape to allow people to easily visually confirm that the trigger of a firearm is covered, which would be a huge benefit for law enforcement officers or people training at a range.

What's Next While the three GunGuardian versions in development are purely mechanical, the design could be adapted to use biometrics in the future. The GunGuardian's adaptability makes it an instructive model for future smart accessories. Harvey and Murphy have completed preliminary prototypes for the TS1, TS2, and TS3, and appeared at the 2018 Shot Show.

LOOKING AHEAD—POLICIES TO SUPPORT INNOVATION

The bold ideas of the entrepreneurs profiled above are bringing us closer to a reality in which firearm safety innovations can start saving lives. As research in this field progresses, it's likely that even more companies will develop designs for personalized guns or accessories.[238] Yet these start-ups still face a critical funding gap.

Organizations like the Smart Tech Challenges Foundation have helped innovators create promising prototypes, but more investment is needed to bring many of these potentially lifesaving products to market. The coming chapters of this report explore the origins of this funding gap and the legislative solutions that can incentivize private investment in gun safety technology.

CONSUMER PREFERENCES AND LEGISLATION

States need to do more to address consumer demand and help bring gun safety technology to market.

The start-ups developing safety technology have been market leaders, selling the first biometric gun lock and designing advanced firearms that leverage cutting-edge recognition technology. Their efforts are poised to have transformative benefits for firearm owners and the general public, letting owners choose among design options to make their firearms more secure.

Once technologically advanced firearms and accessories reach the market, an increasing number of gun owners will gain the ability to protect themselves and their families from unintentional shootings, suicides, and gun thefts. But despite the clear benefits for public safety, opposition to exploring gun safety technology has persisted among gun lobby groups.

These groups often suggest that gun safety technology will lead to the passage of legislation mandating that the technology be sold or purchased, limiting consumer choice. For instance, the NRA says it "doesn't oppose the development of 'smart' guns, nor the ability of Americans to voluntarily acquire them. However, the NRA opposes any law prohibiting Americans from acquiring or possessing firearms that don't possess 'smart' gun technology."[239] Similarly, the National Shooting Sports Foundation (NSSF) claims not to oppose developing personalize guns, but does oppose "government mandates to compel the use of this conceptual technology."[240] Of course, the technology is not conceptual at all, but the NSSF's characterization still attempts to make the case that consumer choice is under siege.

To better understand this concern over consumer choice, it's crucial to examine what we know about consumers' views of personalized guns and accessories—as well as legislative approaches that have attempted to respond to consumer demand for gun safety technology.

CONSUMER PREFERENCES FOR PERSONALIZED GUNS

Surveys show that US gun owners are highly receptive to safety technology. In fact, they are far more receptive than gun lobby messaging suggests.

In the first peer-reviewed poll on this subject—a 2015 national study conducted by researchers at Johns Hopkins University—43% of gun owners reported that they would be willing to buy a "childproof" personalized gun that can be fired only by authorized users. An additional 33% were undecided, but did not rule out the idea.[241] This means that more than 4 out of 10 gun owners would buy a personalized gun and another 3 out of 10 might consider buying one. The 2015 Johns Hopkins poll reflects a marked increase from a 2013 survey conducted by the NSSF, which found at that time that 14% of gun owners were very or somewhat likely to buy a personalized gun.[242]

Even the older NSSF survey indicates enough interest in safer firearms to merit their development. Given that there are an estimated 55 million gun owners, the NSSF survey suggests that at least 7.5 million Americans want to purchase a personalized firearm.[243] It's hard to imagine any other manufacturing industry dismissing the idea of catering to the preferences of "only" 7.5 million of its 55 million customers. The more recent Johns Hopkins study's finding that this preference is actually shared by 43% of gun owners—approximately 24 million people—is even more compelling.

However you slice the data, these numbers show that millions of gun owners want the option to use technology to manage the risks of gun possession. It's easy to imagine which owners would want advanced firearms or locks. For example, a biometric trigger lock could bring peace of mind to someone concerned about a depressed teenage relative. A personalized gun could allow new parents to feel secure

GUN SAFETY TECHNOLOGY IN HIGH DEMAND

A substantial majority of the approximately 55 million US gun owners would buy or might consider buying a handgun equipped with gun safety technology. Over 4 in 10 gun owners said they would buy such a handgun, while an additional 3 in 10 were undecided but open to the idea.[xiv]

that they are taking strong steps to prevent their kids from unintentionally firing their weapon. And a biometric safe could allow law enforcement officers to securely store a service weapon in their vehicle.

GUN SAFETY LEGISLATION AND CONSUMER CHOICE

THE NEW JERSEY MANDATE

The development and marketing of gun safety technology does not, in itself, interfere with retailers' ability to sell traditional firearms and consumers' ability to purchase them. However, some existing and proposed legislation does call for mandating sales of personalized guns under certain conditions.

New Jersey is currently the only state that has adopted legislation like this, though its law has not yet been implemented. New Jersey's law, which was enacted in 2002, will require all handguns sold within the state to be personalized within two to three years after a qualifying personalized handgun is available for sale anywhere in the country.[244] New Jersey defines "personalized handgun" to mean "a handgun which incorporates within its design, and as part of its original manufacture, technology which automatically limits its operational use and which cannot be readily deactivated, so that it may only be fired by an authorized or recognized user."[245] The goal of this first-of-its-kind legislation was to incentivize the development of gun safety technology by ensuring there would be a market for personalized handguns in New Jersey. So far, no qualifying technology has triggered the two-to-three-year clock, so New Jersey's law has not yet been implemented.

After unsuccessfully opposing New Jersey's law, gun lobby groups like the NRA pressured retailers not to sell personalized guns.

While the personalized handgun clock hasn't started, in the 15 years since its enactment, New Jersey's law has had unintended consequences for gun safety technology. After unsuccessfully opposing the mandate, gun lobby groups like the NRA turned their attention to stopping the law from being implemented, pressuring and intimidating manufacturers and retailers who expressed interest in developing or selling personalized guns into abandoning their plans. NRA boycotts induced gunmakers to abandon research and development efforts,[246] and coordinated gun lobby opposition persuaded retailers to drop plans to sell a pistol by Armatix that could have possibly caused the mandate to take effect.[247]

The gun lobby's successful, coordinated opposition to the New Jersey law was especially damaging because it took place precisely when advancements in personalization technology showed significant promise for enabling safer gun designs. In the 16 years since the law's introduction, biometric technology has advanced to the point that affordable fingerprint readers are now included in millions of smartphones—a milestone gun safety developers would ideally have been able to capitalize on. Instead, the hostile climate created by the gun lobby meant that every effort to research, develop, or design a personalized gun was met with reflexive opposition.

After years of observing the impact of New Jersey's law, it is unfortunately apparent that the gun lobby's attack of the mandate has been at least partly responsible for inhibiting the development of personalized guns—doing so against all intentions and reasonable predictions of the law's drafters and supporters.[248] It is unlikely that gun lobby pressure was the sole factor that inhibited innovation, but it appears likely that NRA opposition made it politically riskier for companies and investors to develop gun safety technology.[249]

Because the gun lobby's coordinated opposition to the New Jersey mandate unexpectedly hindered, rather than incentivized, the development of safety technology, in 2016 the law's original sponsor twice sought to amend the law to only require that gun dealers stock *one* model of personalized handgun once such a gun is available for sale.[250] The proposed amendments would have helped preserve consumer choice in New Jersey, but both amendments were vetoed by former Governor Chris Christie, and the original version of the New Jersey mandate remains in place today.[251]

LEGISLATION IN OTHER STATES

Thus far, no state other than New Jersey has directly legislated in the area of gun safety technology. Two states have enacted indirect laws, discussed below, but neither requires that gun safety technology be sold.

MARYLAND

Maryland defines a "personalized handgun" as one that incorporates technology into its design that allows it to be fired only by authorized users. A Maryland law requires the Handgun Roster Board to review the status of personalized handgun technology and report its findings annually to the Governor and the General Assembly.[252] To date, each annual report has concluded that consumers do not yet have access to

this technology. The 2016 and 2017 reports both observed that "the technology to produce personalized handguns does exist," but it has not yet been incorporated into "a commercially available" handgun.[253]

MASSACHUSETTS

Massachusetts includes gun safety technology as a possible alternative to locking devices in a law requiring that any handgun or large-capacity weapon be sold with an approved safety device designed to prevent the discharge of the weapon by unauthorized users.[254] The state police have not yet approved any technology for compliance with this legal requirement.[255]

LEGISLATIVE CHALLENGES AND OPPORTUNITIES

Laws in Maryland and Massachusetts address gun safety technology but don't encourage its development. New Jersey's law was intended to provide incentives for technological development, but its impact was dampened by hardline gun lobby opposition and coordinated efforts to block it from taking effect.

The uncertain effect of past legislation has been a challenge for policymakers looking for impactful ways to support safety technology. But it's important to remember that market changes have improved the outlook for this technology in the years since each of these laws were enacted. As described above, consumer demand has surged, with some 43% of gun owners, or about 24 million people, reporting that they would buy a personalized gun.[256]

This evolving and increasingly more favorable landscape presents a unique opportunity for policymakers to build on the legislative work that has been done in the past. With the right policies to encourage the development of lifesaving technology, the result will be a world in which fewer teens die from suicide, fewer kids injure themselves unintentionally, and fewer crimes are committed with stolen guns.

CLOSING THE FUNDING GAP

The gun lobby's scare tactics and obstructionism have created a funding gap for gun safety technology start-ups.

Safer firearms are within reach and consumer demand for them is growing. Unfortunately, developing gun safety technology is expensive, and not everyone with a viable idea has been able to overcome the unique barriers to innovation in the gun industry. A critical "funding gap" remains—and closing it is imperative to getting safer guns and accessories on store shelves. Closing the gap will require policymakers to fund and encourage the development and sale of this technology so it can gain momentum and start saving lives. **It takes an estimated $20 million for a new company to bring a design for a safer gun or lock from the drawing board to store shelves.** Existing funding sources have fallen short of covering these costs, creating a funding gap that inhibits innovation.

THE ROLE OF GOVERNMENT FUNDING

The National Institute of Justice (NIJ), an arm of the US Department of Justice, funded several gun safety technology projects from the mid-1990s to the mid-2000s. In total, the NIJ gave over $11 million in grants, with a different agency providing an additional $1.5 million.[257] The goal was to encourage grantees to develop guns with "electronic safety mechanisms built in that would prevent anyone other than an authorized user from firing it."[258] Grants went to leading manufacturers,

including Colt and Smith & Wesson, smaller outfits such as FN Manufacturing and iGun Technology, and universities like the New Jersey Institute of Technology.[259]

While government grants produced key research, unfortunately no advanced designs incorporating gun safety technology made it off the drawing board.[260] For the major gun manufacturers, projects were likely stymied by political opposition from corporate gun lobby groups. Reluctant to draw the attention of the NRA and risk boycotts, these manufacturers fell well short of the proposals they had pitched to receive NIJ grants. For example, Smith & Wesson only delivered two prototypes from its $3.7 million grant, although it pitched producing 50 prototypes, and Colt ended up curtailing its internal funding for a personalized handgun project, which was needed to supplement a $500,000 research and development grant it got from the NIJ.[261]

For start-ups and research institutes, the problem may have been that the grants were too low. Researchers at the New Jersey Institute of Technology spent more than a decade developing dynamic grip recognition technology, a novel personalization feature which could work even if a user wears gloves or has wet or bloody hands. The project received several grants, but funding ran out when the researchers were two years away from delivering a prototype that could be commercialized.[262]

Government can and should play a role in encouraging companies and entrepreneurs to develop gun safety technology. But modest grants like those allocated by the NIJ may not be enough. In the future, the most effective encouragement—and that which best leverages government funds—may come in the form of research and development incentives. As things stand today, however, most funding for gun safety technology comes from the private sector.

INVESTMENT HAS HELPED, BUT MORE FUNDING IS NEEDED

Resistance by established manufacturers has created a promising opportunity for start-ups and entrepreneurs to transform the market for gun safety technology. As the innovators profiled in this report demonstrate, there is no shortage of viable ideas aimed at reducing unintentional shootings, suicides, and assaults with stolen guns.

Obtaining at least $20 million in funding, however, has emerged as the biggest barrier to entry for gun safety start-ups. With no significant government grants in this area, funding must come from the private sector, but so far, private sector investment has yet to overcome the funding gap. Three major barriers, discussed below, have inhibited private funding for gun safety technology and must be addressed before lifesaving gun safety technology can move forward.

PERCEIVED POLITICAL RISK

Leading US gun manufacturers likely have ample resources to fund gun safety innovation—if they wanted to. But hardline opposition from the NRA has resulted in manufacturers overwhelmingly choosing not to develop personalized guns and created a pervasive perception that pursuing safer firearms is politically risky. Developers of gun safety technology now must worry that they will be subjected to NRA boycotts, and potential investors fear that political opposition and retailer boycotts will shrink their return on investment.

The risks of developing or investing in safer firearms may be more about perception than reality. Surveys show high consumer demand for personalized guns,[263] and past experience suggests that boycotts would be short-lived once a design's lifesaving potential is appreciated. For example, in the 1970s, the auto industry vehemently lobbied against airbags, but over the next two decades, airbags saved so many lives that opposing them became unconscionable.[264] When lifesaving technology works, it usually becomes unstoppable. But in this case, the *perception* of risk may be inhibiting gun safety technology from getting off the drawing board.

LOW LEVELS OF VENTURE CAPITAL INVESTMENT

Lack of interest from venture capital (VC) firms—a common source of funding for start-ups—has also complicated gun safety companies' efforts to secure adequate funding. Between 2006 and 2015, only six firearm technology or gun safety companies received *any* venture capital funding.[265] With investments totaling only about $110 million over this entire time period, VCs invested in gun safety companies at a fraction of the rates they invested in other industries. For example, **gun safety got about 1% of the funding that went to the cybersecurity industry.**[266]

What explains these surprisingly low investment levels? One answer is that VCs are influenced by the perceived political risks outlined above. The threat of boycotts led by the NRA has, unfortunately, raised the "risk profile" of investing in gun safety—and reduced the chances innovators will get the needed $20 million from investors.

Another answer is that VC funding decisions tend to follow entrenched formulas, with money more likely to go to familiar, close-to-home ideas that are similar to or even copies of successful past investments. In 2015, for example:

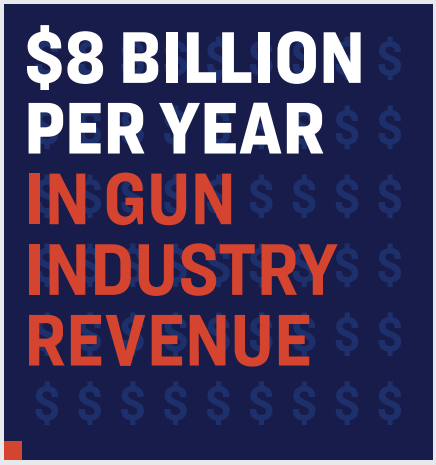
- **78% of investments in start-ups went to just three states: California, New York, and Massachusetts.**
- **Nearly 80% of investments went to companies just 30 miles from investors.**
- **Of the highest-valued start-ups, only 15% were in "real world industries," like agriculture, health, energy, and housing.**[267]

This staggeringly low level of geographic and subject-matter diversity sheds light on what may be causing investors to overlook opportunities to fund smart guns and accessories. Safer firearms are a new investment frontier that does not fit any mold. Formulaic approaches by VCs may be creating a mistaken perception that investing in gun safety is risky or could prove unprofitable, even though there is a potential market of at least 24 million purchasers[268] and gun violence costs the US $229 billion each year[269]—far more than the $20 million it takes to fund a personalized gun.

The fact that firearm ownership is concentrated in regions outside California and New York could also be contributing to a sense that guns are "outside the lane" of investors. It is not surprising that one firearm accessory designer—Omer Kiyani, the inventor of the Identilock—has raised money from gun-owning VCs in his home state, Michigan, rather than from Silicon Valley investors.[270] As Kiyani points out, gun safety could not be more different from the "software as a service" or smartphone apps that make up the typical Silicon Valley investment portfolio.[271]

All this doesn't merely point out a problem with VC investing and gun safety. It also highlights a solution. Investors need to be encouraged to ask whether a bias toward familiar ideas has been steering them away from funding the personalized guns and accessories that could be profitable while also saving lives. VCs should seriously evaluate the merits of promising ideas to improve gun safety and reduce suicides and unintentional shootings, rather than acting on instincts that steer investment to familiar companies in their home city and state. The investors who are able to set aside the tendency to look for entrenched patterns stand to reap greater rewards, as they may be able to identify sound, socially beneficial investments others have overlooked—such as personalized guns.[272]

ROOM FOR INVESTMENT IN GUN SAFETY



$20 million, or 0.25%, would fund one gun safety technology product.

Major American gun manufacturers could easily afford to invest in gun safety technology—if they wanted to. The industry brings in billions of revenue per year, and the likely cost of funding a gun safety technology project is just $20 million.[xv]

TESTING AND PRODUCTION COSTS EXCEED EXISTING PRIVATE GRANTS

Despite missed investment opportunities from venture capital firms, some private individuals have stepped up and offered grants to fund gun safety technology. Venture capital investor Ron Conway led the charge by pioneering a competition to offer grants to fund designs for safer firearms and accessories.[273] In 2013, Conway's competition led to the creation of the Smart Tech Challenges Foundation, which awarded a total of $1 million in grants to 15 innovators.[274] Today, the foundation's research and advocacy has drawn national attention to the importance of

accelerating gun safety technology, and its grants have put several developers on track to produce and sell personalized guns and accessories. The 15 innovators who got grants from Smart Tech Challenges Foundation include Jonathan Mossberg (iGun Technology), Omer Kiyani (Sentinl), and Kai Kloepfer (Biofire Technologies), as well as most of the other individuals and companies profiled in this report.

Already, thanks to the foundation's grants, the future of gun safety technology looks brighter. Omer Kiyani's Identilock has sold thousands of units, meaning thousands of gun owners have more control over the security of their firearms and can better protect their families from unintentional shootings and suicide. And Kai Kloepfer, Jonathan Mossberg, and others have designs in the pipeline that can extend these safety gains to more gun owners and protect even more children and others who are at risk.

However, many of these innovators still need even more capital to get to a market-ready stage of development. The expenses of building, testing, and manufacturing a new gun or accessory are significant, with likely costs of $20 million per design. Due to the high costs of testing and production, most of the 15 entrepreneurs financed by the Smart Tech Challenge's Foundation have encountered a funding gap. Thanks to the initial private grant, they were able to develop a viable idea and build a prototype; however, they currently lack the funds to continue testing it and prepare it for production and marketing. More investment is needed in these potentially lifesaving gun safety innovations.

SMART TECH CHALLENGES FOUNDATION

Since its founding in 2013, the Smart Tech Challenges Foundation has given millions in grants to innovators pursuing designs for personalized firearms, biometric safes, and other gun safety technology. By helping start-ups create workable prototypes and raising awareness of the lifesaving potential of gun safety technology, Smart Tech Challenges is helping to build a safer America. Learn more about their work: smarttechfoundation.org.

THE NEED TO INVEST IN INNOVATION

The funding gap inventors have encountered creates risk and uncertainty. But it turns out they are not alone in facing this barrier to entry. Funding gaps are characteristic of other industries, particularly in areas that present certain risks but also high rewards: improving public health and welfare, and saving innocent lives. That is why the final section of this report is so crucial. It will outline the types of incentives that will help ensure lifesaving personalization technology actually leaves the drawing board and reaches store shelves and gun owners' homes.

INCENTIVES TO PROMOTE GUN SAFETY

Government incentive programs will encourage the investment needed to make safer guns a reality.

Though there has been coordinated opposition from the NRA and other gun lobby groups, safer firearms and accessories that employ gun safety technology are readily within reach. We know these designs are in demand, with roughly 7 out of 10 gun owners reporting that they'd be willing to purchase or consider purchasing a personalized gun. We also know what's at stake:

- **Protecting the 4.6 million kids who live with an easily accessible firearm.**
- **Reducing America's 21,000 annual gun suicides.**
- **Preventing gun thefts and stopping crimes from being committed with some of the 500,000 firearms stolen every year.**

And then there are the intangible benefits: a greater sense of security for those who wish to minimize the collateral risks of keeping a gun in the home. These benefits could be immensely valuable to gun owners, families, and communities suffering the toll of unintentional shootings, firearm misuse, and youth suicide.

With so many lives hanging in the balance, it's time to counter gun lobby inaction with laws and programs to meet consumer demand for better gun safety features and help bring firearms into the 21st century. Entrenched opposition from the gun industry

to safety innovation demands a powerful new approach—one that will harness market forces to ensure that safety technology is developed and brought to market. Policymakers should take decisive steps to overcome gun lobby obstructionism by funding start-ups that are researching and developing gun safety technology and by implementing incentive programs to attract new entrants to the market.

A NEED TO SPEED UP LIFESAVING INNOVATION

Despite the upside for gun owners and communities, progress has been slower than might be expected. Only a handful of new ideas for personalized guns and accessories have been translated into prototypes, and fewer are being commercialized and sold. Large gun manufacturers have resisted progress because they are risk-averse and sensitive to political pressure, while the apparent reticence of private venture capital firms to fund gun safety start-ups has contributed to slowing their progress.

Given the lifesaving potential of user-recognition technology, but the failure of past efforts to commercialize any designs, it's natural to ask: what can be done? What policy approach can encourage gun manufacturers to bring their designs into the 21st century? What can be done to increase access to reliable gun safety technology for the millions of Americans who want it?

CHANGING GUNMAKERS' BUSINESS-AS-USUAL MINDSET

In some respects, encouraging the development of personalized guns and accessories is a tricky task. The gun industry is different from other sectors of the economy, because it has been given special license under federal law to operate how it would like. For example, federal law exempts guns from being regulated under generally applicable consumer product laws, which typically ensure that manufacturers incorporate advancements that make products safer.[275] Another law gives gun manufacturers broad immunity from being sued over their products, making it far less likely fears of litigation will drive development of a safer firearm.[276]

These glaring loopholes have made it all too easy for the gun industry to ignore its moral responsibility to research and develop gun safety technology. Instead, with the tacit permission of federal legislators, and at the behest of the NRA,[277] the gun industry has resisted making any commitments to improve gun safety in ways that might threaten its profits from traditional firearms or dangerous accessories. Even as some manufacturers claim that personalized firearms are impractical or the underlying technology is unattainable,[278] others have shown they are completely

willing to work with advanced electronics in order to make guns more *lethal*.[279] Policy change is urgently needed in order to redirect this same level of innovation and investment into saving lives.

The NRA and gun manufacturers shouldn't be able to falsely claim that there's no way to use technology to improve gun safety and save lives. We know better. Examples from other industries show that overcoming inaction to reduce gun deaths and injuries almost certainly will require changing the gun industry's formula for doing business. To do so, policymakers must leverage changed circumstances that have improved the outlook for gun safety technology, as well as incorporate lessons learned from past attempts to legislate in this area.

CAPITALIZING ON BETTER TECHNOLOGY AND INCREASED CONSUMER DEMAND

A handful of entrepreneurs have already conceived viable designs for safer firearms and accessories that leverage cutting-edge technology, but they need significantly more investment to get their technologies to market.

Unfortunately, the solutions proposed in the past to bridge this funding gap have had a mixed record:

- New Jersey's 2002 legislative mandate for personalized handguns drew an intense backlash from the gun industry, and the gun industry's opposition and extremist positions unexpectedly hindered technological development.[280]
- Private investment from VC firms has been extremely low, in part because of perceived political risk of investing in gun safety technology.[281]
- Private grants have helped, but grants totaling $1 million were not enough to cover steep costs of testing and production.[282]

At the same time, over the last 10 years, technology and the market for personalized guns have undergone transformative changes:

- More reliable fingerprint sensors, faster biometric algorithms, and smaller RFID chips are available.[283]
- Demand has surged: 43% of gun owners would buy a personalized gun.[284]

In short, the market for gun safety technology has changed dramatically since the first proposals for legislative mandates emerged in the early 2000s. These changed circumstances merit a change in tactics to get safer gun designs to market.

Personalized guns cannot gain the necessary momentum—like the unstoppable momentum behind including airbags in cars—until they're actually on the market, saving lives. It's clear this technology needs a financial boost to get to this point, but it's also clear that it is closer than ever to being ready—and that past approaches have not been fully effective at getting gun safety technology across the finish line.

In light of all we know, how should policymakers support the development of personalized firearms and accessories? The most powerful approach would offer grants and other incentives to gun safety technology developers.

A PROMISING NEW APPROACH: INCENTIVES

Saving lives and transforming the market for gun safety technology requires drawing on experiences that have worked to incentivize technological development in other industries. The gun industry's resistance to new technologies is not entirely unique. Advancements in other major industries that have a huge impact on human health and welfare—like the energy and automobile industries—have also been slow.[285] It's common among many industries to initially resist the types of groundbreaking innovations that have the potential to transform their business and their customers' lives, because no individual company wants to be the first to change the playbook. That pattern has unfolded time and again, such as when car manufacturers were reluctant to adopt revolutionary advancements, like airbags and antilock brakes, that now come standard in every vehicle and have been profitable for the auto industry.[286]

In the auto and other industries, lifesaving advancement was achieved only after the government adopted financial incentives to spur innovation.

In the automobile and other industries, lifesaving technological advancement was achieved only after the US government adopted financial incentives to spur innovation and entrepreneurship, including tax credits, grants, and consumer rebates.[287] The results jumpstarted stagnant industries and led to real progress, including the development of drugs to cure rare diseases, new sources of clean energy, and car safety technology. With an initial push in the form of a financial incentive, these lifesaving innovations entered the consumer market, saved many lives, and permanently raised the standards for product safety and human health.

The lesson from these past experiences is clear: the right incentives can overcome funding barriers and industry intransigence and produce the bold advancements necessary to save lives. To overcome gun industry resistance to developing safer

firearms and to strengthen the marketplace for gun safety technology once it is more widely available, the federal and state governments should implement the types of powerful incentives that have worked in these other industries.

LEVERAGING MARKET FORCES FOR SAFETY TECHNOLOGY

Those who oppose government mandates to buy safer firearms, or the development of gun safety technology more generally, often claim the free market should determine whether personalized guns are manufactured and produced.[288] This viewpoint makes sense on the surface. But one potential problem with this approach is that sometimes market forces don't do enough to encourage the initial development of socially beneficial technology. This can occur when technology shows promise to vastly improve human health and welfare, resulting in significant benefits to society, but does not align with the immediate financial interests of the industries capable of developing that technology.

DEFINING FIREARM EXTERNALITIES

The theory described above is well-known among economists—it's an example of an "externality." Advocates for free markets argue that when markets operate efficiently, they make everyone better off. But this doesn't always happen in instances where the interests of market participants don't overlap with the interests of society.[289] When society's interests do not match the interests of market participants, a phenomenon called a market "externality" can be observed.

A negative market externality results when market prices do not take into account all of the negative effects that goods or services produce.[290] These negative effects might include pollution from automobiles, carbon emissions from factories, or unintentional shooting deaths that result when children come across an adult's unsecured firearms. An externality results when a consumer product creates these damaging effects, but the effects are not reflected in the market price of the product—because people, and not the manufacturers, are the ones who suffer.

A negative market externality results when market prices do not take into account all of the negative effects that goods or services produce.

Conversely, a positive externality results when market participants do not factor social benefit into their otherwise-sound investment decisions. For example, building public infrastructure, such as a bridge, may "benefit communities by more than a private investor would take into account," making the bridge (and the investor's failure to help build it) a positive externality.[291]

Thinking about the free market in this way, preventable gun deaths are a type of "negative externality." Gun manufacturers could improve gun designs to reduce accidental shooting deaths. However, because they do not bear the costs of those deaths, they may decline to explore new technology that could prevent injuries and fatalities. Manufacturers' cost-benefit analysis may well see innovation as too risky to justify the initial outlay of capital, even if a successful design would be both profitable and lifesaving. This is a heightened risk in the firearm context, where political pressure to leave gun safety issues to the free market paradoxically exerts an influence on the market not to consider or act to correct negative externalities like those described above.

The flip side is that safer firearms may be a "positive externality." Average investors considering backing a proposal for gun safety technology may make their decision based on a cold numerical assessment of the monetary risks and rewards, without considering the benefits for society. This is more likely to be true where those benefits are beyond quantification, like the value of saving a human life.

CORRECTING FIREARM MARKET EXTERNALITIES

There are indirect ways to correct these externalities, such as by appealing to philanthropic investors, or making the case that consumer demand for personalized guns will make developing them profitable. It may also be possible to make the business case that gun deaths exact an enormous economic cost that should be factored into the business community's decision-making. Gun violence costs America $229 billion annually, and many states bear annual costs exceeding $1 billion.[292]

But the approach economists recommend to deal with externalities requires government intervention, because externalities by definition arise from a breakdown in the free market. This intervention need not come in the form of direct regulation. Rather, policymakers can use the tools of the free market to correct the externalities identified above.

As experts on externalities have observed, when the market is working imperfectly in ways that harm the public, it can be brought into balance through incentives and taxes that balance the market without direct government regulation (which may meet political opposition).[293] The former approach—using incentives and taxes—also has the advantage that it has been used with success in other industries.

ENCOURAGING TECHNOLOGICAL DEVELOPMENT AND BENEFICIAL INVESTMENT

In other instances throughout modern history, the government has pushed important stagnant industries to innovate in ways that benefit society, including by reducing deaths and improving public safety. Sometimes, motivation to innovate has come in the form of financial incentives, such as tax breaks or consumer rebates, rather than laws requiring an industry to take certain actions or achieve certain technological benchmarks.

For example, Congress successfully encouraged pharmaceutical companies to develop drugs for rare diseases by offering a tax break called the Orphan Drug Tax Credit. This legislation created incentives for companies to research and develop drugs that would require a huge initial capital outlay with uncertain future profits, because the market for these drugs is small. The result? Lives were saved because small patient populations were finally able to get treatment for rare diseases.

Congress successfully encouraged pharmaceutical companies to develop drugs for rare diseases by offering a tax break.

Incentives like the Orphan Drug Tax Credit are different from direct government regulation. Policy experts group incentives and direct regulation into distinct buckets. On the one hand are "market-based instruments," which use market forces to incentivize development of beneficial technologies. In addition to the Orphan Drug Tax Credit, another example of a market-based instrument would be a stimulus package to encourage job-building. On the other hand are "command-and-control" policies or "technology-forcing regulations," which require industries to comply with standards set by the government. An example would be banning the use of harmful chemicals in consumer products, or requiring the use of seat belts in cars.[294]

MARKET-BASED INCENTIVES FOR GUN SAFETY TECHNOLOGY

In the gun industry, there is an opportunity to try a legislative approach that has worked in other sectors where manufacturers were slow to innovate to protect public safety. This is the incentive, or market-based, approach. The goal of this approach is to craft and implement policies that function as a "stimulus package" for gun safety technology, including through focused efforts to connect small businesses, start-ups, and entrepreneurs with funding to develop gun safety innovations. Once the technology is being sold, this strategy could also target the demand side, making safer firearms and locking devices more affordable for gun owners to purchase.

BENEFITS OF INCENTIVE LEGISLATION

Incentive legislation could help ameliorate the "funding gap" that is hindering the development of personalized firearms and other gun safety technology. Specifically:

- Incentive legislation will **encourage private funding** by offsetting initial research and development costs.
- Incentives will **make investment in safety technology more attractive** by increasing profit margins once the technology is on the market.
- If enacted in place of a legislative mandate, **incentives could help compensate for or eradicate the perceived heightened risk** of investing in gun safety technology.

Designed properly, incentives would work with market forces by encouraging investment, development, sale, and purchase of gun safety technology. Note that market-based incentives are not a government handout to private industry. Any incentive approach can and should be structured to avoid rewarding nominal efforts at research and development that fail to yield a commercializable product benefiting consumers and public safety.

Designed properly, incentives would work with market forces by encouraging investment, development, sale, and purchase of gun safety technology.

CRAFTING EFFECTIVE INCENTIVES

So how do we get there? There is a good place to start: other industries where incentive models have been effective. Workable incentives on the manufacturing side may differ for individual entrepreneurs, small businesses, or midsize start-ups. On the consumer side, the structure of effective price incentives may ultimately depend on the state of the market once gun safety technology becomes more widely available. But examples from other industries present a menu of options that policymakers can refine.

INCENTIVE MODELS FROM OTHER INDUSTRIES

Policies that have successfully incentivized technological innovation in other industries include supply-side tax credits, commercialization readiness grants, and tax exemptions. On the demand side, effective incentives include consumer rebates, tax credits, and awareness campaigns.

To encourage companies and entrepreneurs to develop safer firearms, and to strengthen the marketplace for them, governments should consider the following incentive-based approaches:

- **Tax credits for developers.** Companies that develop smart guns could qualify for tax credits, modeled after those that incentivize manufacture of energy-efficient appliances or the development of drugs for rare diseases.
- **Commercialization readiness grants.** Grants could be offered to companies meeting benchmarks, like planning to test, market, or produce a personalized firearm or locking device. Grants could be funded through a targeted tax on manufacturers or retailers of traditional firearms.
- **Consumer rebates.** A percentage of the purchase price could be offered as a rebate to consumers who buy a gun, safe, or lock equipped with safety technology—similar to those offered for energy-efficient appliances.
- **Consumer tax credits.** Alternatively, buyers could receive a tax credit up to a certain dollar amount, like the credit offered for alternative fuel vehicles.

Each of these four approaches is discussed in more detail below.

SUPPLY-SIDE INCENTIVES

Supply-side incentives could drive innovation by providing financial benefits to manufacturers taking steps to supply gun safety technology to consumers. Such incentives could offset manufacturers' research, development, or production costs, as well as encourage outside investment in gun safety technology to further expand manufacturing capacity.

TAX CREDITS—PHARMACEUTICAL MODEL

Governments have often used tax credits to help encourage the development of beneficial technology. Tax credits can help minimize the risk of entering a socially beneficial industry by making research and development costs eligible for a credit, including employee salaries and third-party contractor wages, as well as costs like reliability testing and patent applications. There is already a research and development tax credit,[295] but a specific credit for gun safety technology would provide an extra incentive.

The tax credit could be modeled after successful pharmaceutical industry credits, like the Orphan Drug Tax Credit (ODTC), which offers an up to 50% credit for eligible costs of developing drugs to treat rare diseases. The ODTC works: it has been linked to a 33% increase in drugs for rare diseases ("orphan drugs") approved for sale.[296] In some ways, orphan drugs are similar to personalized guns. Orphan drugs save lives,

but companies thought that low patient demand would prevent them from recovering research and development costs. Similarly, personalized guns could save many lives from suicide and unintentional shootings, but some manufacturers fear that developing them would be unprofitable (or threaten profits from traditional fireams). A tax credit like the ODTC could help drive innovation by overcoming manufacturers' profitability concerns.

One possible objection to a tax credit scheme is that, in the past, large US gun manufacturers have accepted grant money but failed to deliver marketable prototypes. It is reasonable to be concerned that some manufacturers might take a tax credit and then avoid actually bringing a personalized gun or other safety technology to market. Different tax structures could mitigate this concern. For example, a credit could be geared toward small businesses and exclude big manufacturers whose gross sales receipts exceed a set threshold. In some instances, it may also be desirable to give specific tax benefits to start-ups that are seeking funding for but have not yet started manufacturing guns or accessories equipped with gun safety technology, like by allowing qualifying small businesses to apply the credit to their payroll taxes.

A tax credit could be geared toward small businesses and exclude big manufacturers whose gross sales receipts exceed a set threshold.

TAX CREDITS—CLEAN ENERGY MODEL

Alternatively, future policymakers could tie eligibility for a tax credit to actual production of personalized guns or accessories. Such a tax credit could be modeled after credits for production of energy-efficient appliances[297] or the renewable electricity production credit.[298] A similar type of credit could be employed to cover manufacturing costs, like Vermont's tax incentive for sustainable energy technology.[299] That incentive offers a 30% credit for expenditures made to design, develop, or manufacture equipment used to generate sustainable energy.

COMMERCIALIZATION READINESS GRANTS

In addition to tax credits, grants could be offered to companies that meet certain benchmarks, such as completing reliability testing of a prototype, or preparing to commercialize and produce a personalized gun. This approach would reward concrete innovation, but would not assist companies who need funding for earlier stages of research and development, like the New Jersey Institute of Technology group who was exploring dynamic grip recognition but was two years away from a prototype.

A possible middle ground would be to set up a grant system that provides incremental and increasing grants as a company gets closer to market readiness. A grant model could be the National Institute of Health's Small Business Innovation Research (SBIR) program, Small Business Technology Transfer (STTR) program, and Commercialization Readiness Pilot (CRP) program.[300] The first two grants were designed to establish the technical merit and feasibility of new technology and advance it toward commercialization, but the last component was piloted because it was realized that medical biotechnology products reached a "valley of death," or a funding gap, after receiving the first grants but before a product was market ready. A similar government grant program could bridge the same sort of funding gap that is currently hindering the advancement of gun safety technology.

FUNDING GRANTS THROUGH A FIREARM BUSINESS TAX

Legislatures seeking to fund grants for gun safety innovators could consider taxing manufacturers and dealers of traditional firearms and dangerous accessories.[301] For instance, a state could tax all income earned within the state by gun manufacturers and retail sellers that is attributable to traditional firearms, or to accessories that boost guns' lethality, like laser sights, trigger activators, or large-capacity ammunition magazines. The proceeds from the tax could be used to award commercialization readiness grants to start-ups and entrepreneurs who are developing safer firearms and accessories. This funding source targets those manufacturers of traditional guns who have avoided making any effort to explore design changes that can make firearms safer.

Proceeds linked to the manufacture and sale of personalized guns or accessories could be exempted from a manufacturer and retailer tax, in order to provide an additional incentive for their development.

A government program could bridge the funding gap that is currently hindering the advancement of gun safety technology.

OTHER TAX EXEMPTIONS

There is a federal excise tax applicable to gun sales by manufacturers, producers, and importers (10% for handguns and 11% for long guns).[302] Manufacturers could be exempted from having to pay the excise tax for qualifying personalized guns or accessories, reducing their costs of selling them to retailers. Alternatively or in addition to this exemption, the federal government could consider increasing the federal firearm excise tax and redirecting the additional proceeds to support gun safety technology.

DEMAND-SIDE INCENTIVES

Demand-side incentives can encourage technological innovation by ensuring that once gun safety technology is perfected, it is affordable for consumers who wish to purchase it. These incentives can also empower consumers to assert their right to support companies developing beneficial technology, including by educating gun buyers about their choice to purchase safer firearms.

RETAIL AND CONSUMER REBATES OR TAX CREDITS

As part of a demand-side incentive plan, governments could fund a rebate system where consumers who purchase an approved personalized gun or locking device are refunded a certain percentage of the purchase price, similar to the rebates offered for energy-efficient appliances.[303] A rebate could also be extended to retailers to encourage them to purchase, test, and sell gun safety technology to consumers.

Retailer or purchaser incentives for eligible personalized guns and accessories could be provided through a tax credit of up to a certain dollar amount, like the alternative fuel source motor vehicle credit.[304] Some states and local governments offer tax credits and rebates toward the purchase of other gun safety accessories, like safes and trigger locks. For example:

- **Connecticut, Massachusetts, and New Jersey** exempt gun locks and safes from state sales tax, and New Jersey's law also exempts devices that limit access to a firearm by unauthorized users.[305]
- **Washington State** exempts gun safes from the state sales tax.[306]
- The city of **Northglenn, Colorado,** reimburses residents over age 21 up to 25% or $500 on purchases of a gun safe meeting specified safety criteria.[307]

Any of these tax credit or rebate policies could be a model for similar policies incentivizing the purchase of personalized guns and accessories.

GRANTS FOR PUBLIC AWARENESS CAMPAIGNS

Consumer demand may be shaped by inaccurate perceptions, fueled by the gun lobby, that personalized guns fail to provide meaningful safety benefits. Once dependable personalized guns are available to consumers, grants could be offered to states to develop campaigns to educate people about the dangers of gun thefts, child and teen accidents, and suicides. The grants could be modeled on those provided to encourage child safety seats in vehicles[308] or discourage alcohol-impaired driving.[309]

Consumer demand may also be affected by existing misinformation. For example, criticisms of current user-authorization technology focus on failure rates of fingerprint-unlock systems and the idea that a battery could fail at a crucial

moment. However, these may not be accurate critiques for the BioFire Technologies' fingerprint-based personalized gun, which reports a fingerprint-unlock failure rate as low as 0.01%,[310] or iGun's shotgun, which has a battery life exceeding 10 years.[311] Awareness campaigns could educate the public about the dependability of safety technology, such as by publishing the results of impartial reliability testing.

MORE OPTIONS, MORE BENEFITS

The recommendations above are not intended to prescribe a specific set of incentives, but to provide a menu of options for policymakers to consider. Specific incentives may need to be designed in consultation with tax experts and economists, who may propose new ways to spur technological development beyond the ideas presented here. Hopefully, this report provides a productive framework for thinking about how to incentivize gun safety innovation and bring lifesaving technologies to market.

In part because creating incentives for a robust market for personalized guns and accessories requires bold thinking and experimentation, the results may be years in the making. Crafting an effective package of incentives for gun safety technology may require legislators to conduct an even closer examination of the current technology and pertinent market forces. And incorporating cutting-edge user-recognition technology into a firearm, safe, or trigger lock may require years of effort for the manufacturers, inventors, and entrepreneurs taking on the tough challenge of developing safer guns.

But at the finish line of all this is an America where consumers who choose to own a gun can also make sure that gun cannot be fired by anyone they don't authorize. And it will be a nation where fewer children and adults die from gun accidents and suicides, or are killed in an assault by someone using a stolen gun. It is imperative that we spend the time to craft effective incentive-based stimulus policies for gun safety technology that can bring our country to that safer future.

KEY INCENTIVES

- Tax Credits for Developers
- Commercialization Readiness Grants
- Consumer Tax Credits
- Consumer Rebates

CONCLUSION

Gun safety technology has the potential to save thousands of the lives currently lost to gun violence each year.

American children are 16 times more likely to die in unintentional shootings than children in other high-income nations—because they are more likely to come across an unsecured firearm in the home. The majority of teens who take their own lives with guns make this decision in a matter of minutes, aided by the relative ease of accessing an adult's gun. Each year, hundreds of thousands of guns are stolen, and up to 15% of these guns are later used to commit crimes. Gun safety technology such as personalized guns, safes, and trigger locks can prevent many of these tragic deaths.

The stories covered in this report serve as examples of how stalled safety innovation costs lives. If Corbin Wiederholt's grandfather's gun had been equipped with a fingerprint scanner, Corbin's five-year-old brother couldn't have fired the gun, and Corbin would still be alive today. If the gun 12-year-old Alicia used to take her own life had been stored with a biometric trigger lock, Alicia would still be alive today. If the stolen gun used to shoot Oakland muralist Antonio Ramos had been locked with RFID technology, Antonio would still be alive today.

The technology needed to save these lives exists. The challenge of bringing secure firearms and safes to the market is not technological, but political and financial, with the NRA and other gun lobby groups using bullying and boycotts to stall innovation at every turn.

Despite the gun lobby's resistance, there is high consumer demand for gun safety technology, with millions of Americans reporting they would purchase a personalized gun. Start-ups and entrepreneurs are beginning to fill the innovation void left by big gun manufacturers, developing reliable products that use common technology like RFID chips and fingerprint scanners to prevent children and other unauthorized users from accessing guns.

Yet these innovators face a critical funding gap. It takes an estimated $20 million to bring a personalized gun or accessory to market, yet between 2006 and 2015, venture capital firms invested in only six firearm technology or gun safety companies at a fraction of the rates they invested in other industries.

The most effective way to close this funding gap is for lawmakers to adopt policies that will create incentives for investment in gun safety technology, rewarding investors and consumers with tax credits, grants, and rebates.

Once start-ups have the funding they need to bring gun safety technology to consumers, the rest of the gun industry will have to adapt or risk being left behind. Automakers initially resisted airbags and other crucial car safety features we now take for granted. But over time, these safety features became standard and gained widespread public acceptance—and saved tens of thousands of lives. The same is possible with gun safety technology.

This report provides a pathway for policymakers who want to solve America's gun violence crisis, recommending concrete steps that can—and must—be taken to turn the tide on child gun injuries, gun suicide, and firearm theft. Let's take these steps together.

Leverage the legal and policy acumen of Giffords Law Center to help incentivize gun safety techology in your state and save lives from gun violence. For more information, email **lawcenter@giffords.org**.

ENDNOTES

REPORT ENDNOTES

1. Chris Evans, "98 Percent of Americans Are Connected to High-Speed Wireless Internet," *White House Blog*, March 24, 2015, **https://obamawhitehouse.archives.gov/blog/2015/03/23/98-americans-are-connected-high-speed-wireless-internet**; Aaron Smith, "Record Shares of Americans Now Own Smartphones, Have Home Broadband," *Fact Tank* (blog), Pew Research Center, January 12, 2017, **http://www.pewresearch.org/fact-tank/2017/01/12/evolution-of-technology**.

2. *See* Tony Borroz, "Strapping Success: The 3-Point Seat belt Turns 50," *Wired,* August 13, 2009, **https://www.wired.com/2009/08/strapping-success-the-3-point-seat belt-turns-50**.

3. Susan Gilbert, "Child-Resistant Medicine Caps Do Save Lives," *New York Times*, June 5, 1996, **http://www.nytimes.com/1996/06/05/us/child-resistant-medicine-caps-do-save-lives.html**.

4. "Saving Lives with Car Seats and Seat Belts," American Academy of Pediatrics, accessed April 23, 2018, **https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/7-great-achievements/Pages/Saving-Lives-with-Car-Seats-and-Seat-Belts.aspx**.

5. In 2016, 38,658 Americans died from gun violence and another 116,414 were nonfatally wounded. "Fatal Injury Data and Non-Fatal Injury Data," Centers for Disease Control and Prevention, Web-based Injury Statistics Query and Reporting System (WISQARS), **https://www.cdc.gov/injury/wisqars**; *see also* "Facts About Gun Violence," Giffords Law Center to Prevent Gun Violence, **http://lawcenter.giffords.org/wp-content/uploads/2018/05/Facts-About-Gun-Violence-5.10.18.pdf**.

6. *See* Stephen P. Teret and Adam D. Mernit, "Personalized Guns: Using Technology to Save Lives," in *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013), 175.

7. "Guns and Coders," BBC Radio 4, July 17, 2017, 0:26–1:43, **http://www.bbc.co.uk/programmes/b08y02wy.**

8. Ibid., 0:31–1:16.

9. Ibid., 1:16–1:43.

10. Lauren Marcy, "Preventing Teen Suicide: When to Remove Firearms from Your Home," *University of Michigan Children's Health Blog*, March 23, 2018, **https://healthblog.uofmhealth.org/childrens-health/preventing-teen-suicide-when-to-remove-firearms-from-your-home**.

11. Mark Dewey, "A New 'Smart Rifle' Decides When to Shoot and Rarely Misses," *All Things Considered*, NPR, May 15, 2013, **https://www.npr.org/sections/alltechconsidered/2013/05/15/184223110/new-rifle-on-sale**.

12. Unlike every other consumer product produced in the US, firearms and ammunition are exempted from the health and safety standards set by the federal Consumer Product Safety Act. *See* 15 U.S.C. § 2052(a)(1)(ii)(E), referencing 26 U.S.C. § 4181.

13. "Gun Industry Immunity," Giffords Law Center to Prevent Gun Violence, accessed October 28, 2017, **http://lawcenter.giffords.org/immunity**.

14. Leo Wolinsky, "Big Lobbies Clash in Fight on Seat Belts: Hearings Open Today as California Joins Auto Safety Debate," *Los Angeles Times*, February 19, 1985, **http://articles.latimes.com/1985-02-19/news/mn-546_1_seat-belts**.

15. Michael S. Rosenwald, "Maryland Dealer, Under Pressure from Gun-Rights Activists, Drops Plan to Sell Smart Gun," *Washington Post*, 2, 2014; *see also* Jeremy W. Peters, "'Smart' Firearm Draws Wrath of the Gun Lobby," *New York Times*, April 27, 2014, **https://www.nytimes.com/2014/04/28/us/politics/smart-firearm-draws-wrath-of-the-gun-lobby.html**.

16. *See* "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 31:00–31:20, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2** (interview with David Hemenway).

17. Violence Policy Center, "Gun Deaths Surpass Motor Vehicle Deaths in 21 States and the District of Columbia," news release, January 11, 2016, **http://www.vpc.org/press/gun-deaths-surpass-motor-vehicle-deaths-in-21-states-and-the-district-of-columbia**; *See also* "Bangers v Bullets: A Gun Is Now More Likely to Kill You than a Car Is," *Economist*, January 8, 2015, **https://www.economist.com/news/united-states/21638140-gun-now-more-likely-kill-you-car-bangers-v-bullets**.

18. Stephen P. Teret and Adam D. Mernit, "Personalized Guns: Using Technology to Save Lives," in *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013), 175.

19. "Guns and Coders," BBC Radio 4, radio program, July 17, 2017, 0:26–1:43, **http://www.bbc.co.uk/programmes/b08y02wy.**

20. American Academy of Pediatrics, "Policy Statement: Firearm-Related Injuries Affecting the Pediatric Population," *Journal of Pediatrics* 130, no. 5 (Nov. 2012): e1416.

21. A start-up in Texas has built a $22,000 "smart rifle" with a built-in laser range finder, ballistics computer, and Wi-Fi transmitter; Remington has plans to incorporate the technology into a cheaper rifle. Mark Dewey, "A New 'Smart Rifle' Decides When to Shoot and Rarely Misses," *All Things Considered*, NPR, May 15, 2013, **https://www.npr.org/sections/alltechconsidered/2013/05/15/184223110/new-rifle-on-sale**.

22. *See* Sarah Childress, "What Happened When A Major Gun Company Crossed the NRA," *Frontline*, PBS, January 16, 2005, 3:40–5:18, **https://www.pbs.org/wgbh/frontline/article/what-happened-when-a-major-gun-company-crossed-the-nra**.

23. For instance, after the mass school shooting in Parkland, Florida, the manufacturer of the shooter's weapon responded to public criticism by announcing that it does not invest any research and development money in "safety through technology" programs, and that in fact, it would be "irresponsible" "to divert significant resources to these initiatives … when the most recent market research shows there is very little interest or desire among firearm consumers for 'smart gun' products, even if they were available." American Outdoor Brands Corporation, "American Outdoor Brands Corporation Issues Detailed Rebuttal to BlackRock," news release, March 6, 2018, **https://www.valuewalk.com/2018/03/american-outdoor-brands-corporation-issues-detailed-rebuttal-to-blackrock**; cf. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041 (Johns Hopkins survey found that 43% of gun owners would buy a personalized gun if one was on the market).

24. *See*, e.g., American Outdoor Brands Corporation, "American Outdoor Brands Corporation Issues Detailed Rebuttal to BlackRock," news release, March 6, 2018, **https://www.valuewalk.com/2018/03/american-outdoor-brands-corporation-issues-detailed-rebuttal-to-blackrock**; Gun lobby groups have boycotted manufacturers who made commitments to develop gun safety

technology, and more recently supported boycotts against retailers who planned to sell firearms with technologically-advanced safety features. Sarah Childress, "What Happened When A Major Gun Company Crossed the NRA," *Frontline*, PBS, January 16, 2005, 3:40–5:18, **https://www.pbs.org/wgbh/frontline/article/what-happened-when-a-major-gun-company-crossed-the-nra**; Jeremy W. Peters, "'Smart' Firearm Draws Wrath of the Gun Lobby," *New York Times*, April 27, 2014, **https://www.nytimes.com/2014/04/28/us/politics/smart-firearm-draws-wrath-of-the-gun-lobby.html?mcubz=3**.

25. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

26. "FastStats: All Injuries," Centers for Disease Control and Prevention, National Center for Health Statistics, accessed March 25, 2018, **https://www.cdc.gov/nchs/fastats/injury.htm**.

27. Leo Wolinsky, "Big Lobbies Clash in Fight on Seat Belts: Hearings Open Today as California Joins Auto Safety Debate," *Los Angeles Times*, February 19, 1985, **http://articles.latimes.com/1985-02-19/news/mn-546_1_seat-belts**.

28. *See* Dean Takahashi, "Charlie Walton, Inventor of RFID, Passes Away at 89," *Venture Beat*, November 27, 2011, **https://venturebeat.com/2011/11/27/charlie-walton-inventor-of-rfid-passes-away-at-89**.

29. "Biometric Gun Safes," Walmart, accessed October 17, 2017, **https://www.walmart.com/c/kp/biometric-gun-safes**.

30. "Fatal Injury Data and Non-Fatal Injury Data," Centers for Disease Control and Prevention, Web-based Injury Statistics Query and Reporting System (WISQARS), **https://www.cdc.gov/injury/wisqars**; "Lethality of Suicide Method," Harvard TH Chan School of Public Health, Means Matter, **http://www.hsph.harvard.edu/means-matter/means-matter/case-fatality**. 21,000 gun suicides represents a yearly average calculated from 2011 to 2015.

31. *See* "Suicide Prevention—Suicide Statistics," Mental Health America, **http://www.mentalhealthamerica.net/suicide**; "Risk Factors and Warning Signs," American Foundation for Suicide Prevention, **https://afsp.org/aboutsuicide/risk-factors-and-warning-signs**.

32. American Academy of Pediatrics, "Policy Statement: Firearm-Related Injuries Affecting the Pediatric Population," *Journal of Pediatrics* 130, no. 5 (Nov. 2012): e1416.

33. Deborah Azrael, Joanna Cohen, Carmel Salhi, and Matthew Miller, "Firearm Storage in Gun-owning Households with Children: Results of a 2015 National Survey." *Journal of Urban Health* (2018): 1–10.

34. Christopher Ingraham, "People Are Getting Shot By Toddlers On A Weekly Basis This Year, *Washington Post*, October 14, 2015; Christopher Ingraham, "American Toddlers are Still Shooting People On a Weekly Basis this Year," *Washington Post*, September 29, 2017.

35. Stephen P. Teret and Adam D. Mernit, "Personalized Guns: Using Technology to Save Lives," in *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013), 175; *see also* Philip J. Cook, Stephanie Molliconi, Thomas B. Cole, "Regulating Gun Markets," *Journal of Criminal Law and Criminology* 86, no. 1 (Fall 1995).

36. Dan Noyes, "How Criminals Get Guns," *Frontline*, PBS, **http://www.pbs.org/wgbh/pages/frontline/shows/guns/procon/guns.html**.

37. "Profile of Jonathan Mossberg," Smart Tech Challenges Foundation, accessed August 20, 2017, **https://smarttechfoundation.org/smart-firearms-technology/jonathan-mossberg-2**.

38. "Biometric Gun Safes," Walmart, accessed October 17, 2017, **https://www.walmart.com/c/kp/biometric-gun-safes**; "Identilock FAQs—Fit Guide," Identilock, accessed September 9, 2017, **https://getidentilock.com/apps/help-center**.

39. B. Gil Horman, "The Basics of Laser Sights," *American Rifleman*, September 19, 2011; "Lethal and Legal: 9 Products That Could Be the Next Bump Stock," Giffords, Nov. 15, 2018, **https://giffords.org/wp-content/uploads/2017/11/Giffords-Lethal-and-Legal-1.pdf**. Even before these dangerous new accessories hit the market, gunmakers focused on aggressively promoting military-style weaponry and firearms that can be equipped with larger magazines. "Backgrounder on Glock 19 Pistol and Ammunition Magazines Used in Attack on Representative Gabrielle Giffords And Others" Violence Policy Center, 1 (Jan. 2011), **http://www.vpc.org/fact_sht/AZbackgrounder.pdf**.

40. *See* "'Smart' Guns and Personalized Firearms," NRA-ILA Institute for Legislative Action, accessed September 12, 2017, **https://www.nraila.org/get-the-facts/smart-gunspersonalized-firearms**.

41. John Rudolf, "Smith & Wesson Broke Clinton-Era Gun Safety Pledge to Boost Profits," *Huffington Post*, December 23, 2012, **https://www.huffingtonpost.com/2012/12/21/smith-wesson-clinton-bush-nra_n_2348503.html**.

42. *See* "Smart Gun Technology Should Be Embraced, Not Feared," *South Florida Sun-Sentinel*, Sep. 2, 2016, **http://www.sun-sentinel.com/opinion/fl-column-andrew-smart-guns-20160902-story.html** (describing NRA opposition to law).

43. Ibid; *see also* Michael S. Rosenwald, "Maryland Dealer, Under Pressure from Gun-Rights Activists, Drops Plan to Sell Smart Gun," *Washington Post*, May 2, 2014; Jeremy W. Peters, "'Smart' Firearm Draws Wrath of the Gun Lobby," *New York Times*, April 27, 2014, **https://www.nytimes.com/2014/04/28/us/politics/smart-firearm-draws-wrath-of-the-gun-lobby.html**.

44. *See*, e.g., *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013) (recommending evidence-based policies to reduce American gun violence).

45. E.g., Christina Pazzanese, "Parkland Students: The Violence Must Stop Here," *Harvard Gazette*, March 20, 2018, **https://news.harvard.edu/gazette/story/2018/03/parkland-students-the-violence-must-stop-here** (quoting survivor of mass school shooting in Parkland, Florida: "We *See* past the façade that this is inevitable and this is the price of our freedom").

46. "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 7:30–9:03, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2**.

47. Compare Frank Miniter, "The Smart-Gun Maker Who Told Holder Off," *National Review*, August 11, 2014, **http://www.nationalreview.com/article/385109/smart-gun-maker-who-told-holder-frank-miniter** (observing that "digital technology isn't what [manufacturers] do"), and Outdoor Brands Corporation Issues Detailed Rebuttal to BlackRock," news release, March 6, 2018, **https://www.valuewalk.com/2018/03/american-outdoor-brands-corporation-issues-detailed-rebuttal-to-blackrock** ("We are a manufacturing company, not a technology company, and we are poorly situated to hire those with the knowledge and expertise to develop such technology and to otherwise compete with technology companies who are far more knowledgeable in this area"); with Mark Dewey, "A New 'Smart Rifle' Decides When To Shoot And Rarely Misses," *All Things Considered*, NPR, May 15, 2013,

https://www.npr.org/sections/alltechconsidered/2013/05/15/184223110/new-rifle-on-sale (members of gun industry are interested in producing rifles equipped with lasers and computers to vastly—and dangerously—improve long-range shooting accuracy).

48. E.g., Yuri Kageyama, "Hitachi Shows Off World's Smallest RFID Chip," Associated Press for NBC News, Feb. 22, 2017, **http://www.nbcnews.com/id/17284751/ns/technology_and_science-innovation/t/hitachi-shows-worlds-smallest-rfid-chip**; Patrick Moorhead, "Synaptics Shipping First In-Display Smartphone Fingerprint Reader With Vivo," *Forbes*, Dec. 14, 2017, **https://www.forbes.com/sites/patrickmoorhead/2017/12/14/synaptics-shipping-first-in-display-smartphone-fingerprint-reader-to-vivo**; Vlad Savov, "I Tried the World's First Phone With an In-Display Fingerprint Sensor," *Verge*, Jan. 9, 2018, **https://www.theverge.com/circuitbreaker/2018/1/9/16867536/vivo-fingerprint-reader-integrated-display-biometric-ces-2018**.

49. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

50. Michael Addady, "A Tiny Percentage of US Adults Own Half the Country's Guns," *Fortune*, September 19, 2016, **http://fortune.com/2016/09/19/us-gun-ownership** (estimating 55 million gun owners in America).

51. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," *Crain's Detroit (MI) Business*, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock**.

52. Geoffrey A. Fowler, "A 19-Year-Old Just Built the First Fingerprint-Reading Smart Gun," *Wall Street Journal*, Oct. 7, 2016, **http://archive.is/PDMe8#selection-3887.0-3887.64**.

53. "Profile of Jonathan Mossberg," Smart Tech Challenges Foundation, accessed August 20, 2017, **https://smarttechfoundation.org/smart-firearms-technology/jonathan-mossberg-2**.

54. "Profile of Rob Harvey and Will Murphy," Smart Tech Challenges Foundation, accessed August 20, 2017, **https://smarttechfoundation.org/smart-firearms-technology/will-murphy-rob-harvey**.

55. "Profile of Timmy Oh," Smart Tech Challenges Foundation, accessed August 14, 2017, **https://smarttechfoundation.org/smart-firearms-technology/timmy-oh**.

56. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," *Crain's Detroit (MI) Business*, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock**; see also Mark Wallace, "How Young Entrepreneurs Are Devising Tech Solutions to Gun Violence," *Fast Company*, March 23, 2018, **https://www.fastcompany.com/40548305/how-young-entrepreneurs-are-devising-tech-solutions-to-gun-violence**.

57. *See*, e.g., Sarah Childress, "What Happened When a Major Gun Company Crossed the NRA," *Frontline*, PBS, January 16, 2005, 3:40–5:18, **https://www.pbs.org/wgbh/frontline/article/what-happened-when-a-major-gun-company-crossed-the-nra**.

58. Joe Garofoli, "Can Tech Really Disrupt Gun Violence?" *San Francisco Chronicle*, January 9, 2016, **http://www.sfchronicle.com/business/article/can-tech-really-disrupt-gun-violence-6748327.php**.

59. Ibid.

60. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

61. Joe Garofoli, "Can Tech Really Disrupt Gun Violence?" *San Francisco Chronicle*, January 9, 2016, **http://www.sfchronicle.com/business/article/can-tech-really-disrupt-gun-violence-6748327.php**.

62. Ibid.

63. Michael Addady, "A Tiny Percentage of US Adults Own Half the Country's Guns," *Fortune*, September 19, 2016, **http://fortune.com/2016/09/19/us-gun-ownership**.

64. *See*, e.g., Ben Schiller, "Why Venture Capitalists Aren't Funding the Businesses We Need," *Fast Company*, September 28, 2017, **https://www.fastcompany.com/40467045/why-venture-capitalists-arent-funding-the-businesses-we-need**; Ross Baird, *The Innovation Blind Spot: Why We Back the Wrong Ideas and What to Do about It* (Dallas: BenBella Books, Inc., 2017).

65. Mark Follman, Julia Lurie, Jaeah Lee, and James West, "The True Cost of Gun Violence in America," *Mother Jones*, April 15, 2015, **https://www.motherjones.com/politics/2015/04/true-cost-of-gun-violence-in-america**.

66. Chuck Salter, "Silicon Valley's Smart Tech Foundation Launches $1 Million Competition For Safer Guns," *Fast Company*, November 6, 2013, **https://www.fastcompany.com/3021232/silicon-valley-trio-launches-1-million-competition-for-smarter-safer-guns-exclusive**; "About Us," Smart Tech Challenges Foundation, accessed May 9, 2018, **https://smarttechfoundation.org/about**.

67. *See*, e.g., "Seat Belt Use in US Reaches Historic 90%: Lives Saved Estimated at Nearly 345,000 Since 1975," National Highway Traffic Safety Administration, November 21, 2016, **https://www.nhtsa.gov/press-releases/seat-belt-use-us-reaches-historic-90-percent** (crediting federal legislation and policies, "including incentive grants and support for enforcement" of seat belt laws, for driving up rates of seat belt use).

68. Ernst and Young, "Impact of the Orphan Drug Tax Credit on Treatments for Rare Diseases" (prepared for by Biotechnology Industry Organization and the National Organization for Rare Disorders, June 2015), **https://www.bio.org/sites/default/files/EY%20BIO%20Orphan%20Drug%20Tax%20Credit%20Report%202015%2006%2016.pdf** (tax credit program for developers of drugs for rare diseases that affect fewer than 200,000 people resulted in a 33% increase in such drugs made available for sale); "SBIR/STTR Commercialization Readiness Pilot (CRP) Program," National Institutes of Health, accessed July 18, 2017, **https://grants.nih.gov/grants/guide/pa-files/PAR-16-026.html** (explaining the importance of government grants for medical biotechnology companies because "development of medical biotechnology products is often impeded by a significant funding gap, known as the 'Valley of Death,'" following development of a product but before it has been commercialized for sale).

69. *See*, e.g., American Outdoor Brands Corporation, "American Outdoor Brands Corporation Issues Detailed Rebuttal to BlackRock," news release, March 6, 2018, **https://www.valuewalk.com/2018/03/american-outdoor-brands-corporation-issues-detailed-rebuttal-to-blackrock** (letter from Smith & Wesson's parent company, in response to mass school shooting where shooter used firearm manufactured by Smith & Wesson stating "We do not believe that our stockholders associate the criminal use of a firearm with the company that manufactures it").

70. "SBIR/STTR Commercialization Readiness Pilot (CRP) Program," National Institutes of Health, accessed July 18, 2017, **https://grants.nih.gov/grants/guide/pa-files/PAR-16-026.html**.

71. "Manufacturers' Energy Efficient Appliance Credit," Internal Revenue Service, accessed August 26, 2017, **https://www.irs.gov/businesses/corporations/manufacturers-energy-efficient-appliance-credit**.

72. "Renewable Electricity Production Tax Credit (PTC)," Energy.gov, accessed August 26, 2017, **https://energy.gov/savings/renewable-electricity-production-tax-credit-ptc**.

73. 26 U.S.C. § 45C (Clinical Testing Expenses for Certain Drugs for Rare Diseases or Conditions); *but see* Zachary Brennan, "Senate, House Agree to Cut Orphan Drug Research Credit in Half in Tax Bill," *Regulatory Focus*, December 18, 2017, **https://www.raps.org/regulatory-focus%E2%84%A2/news-articles/2017/12/senate,-house-agree-to-cut-orphan-drug-research-credit-in-half-in-tax-bill**.

74. 26 U.S.C. § 4181.

75. "Find Product Rebates and Other Offers," Energy Star, accessed July 15, 2017, **https://www.energystar.gov/rebate-finder**.

76. "Alternative Motor Vehicle Credit," Internal Revenue Service, accessed July 15, 2017, **https://www.irs.gov/newsroom/alternative-motor-vehicle-credit-1**.

77. Connecticut, Massachusetts, and New Jersey exempt gun locks and gun safes from state sales taxes, and Washington exempts gun safes. Conn. General Stat. § 12-412(101); Mass. Gen. Laws ch. 64H, § 6(rr); N.J. Stat. Ann. §§ 54:32B-8.50 & -8.51; Wash. Rev. Code § 82.08.832.

78. *See* Mark Joseph Stern, "How to Make the Gun Industry Pay," *Slate*, November 6, 2017, **http://www.slate.com/articles/news_and_politics/jurisprudence/2017/11/a_special_tax_on_the_firearm_industry_is_the_only_way_to_make_victims_of.html**.

79. *See* Robert Triggs, "How Fingerprint Scanners Work: Optical, Capacitive, and Ultrasonic Variants Explained," February 9, 2016, **https://www.androidauthority.com/how-fingerprint-scanners-work-670934**.

80. *See* Mark Roberti, "The History of RFID Technology," January 16, 2005, **http://rfidjournal.com/articles/view?1338**.

81. Josh Harkinson, "Welcome to the Future of Gun Control," *Mother Jones*, March/April 2016, **http://www.motherjones.com/politics/2016/02/smart-guns-mossberg-igun-venture-capital-conway**.

82. Buck Rogers was a popular sci fi character. Dean Takahashi, "Charlie Walton, Inventor of RFID, Passes Away at 89," *Venture Beat*, November 27, 2011, **https://venturebeat.com/2011/11/27/charlie-walton-inventor-of-rfid-passes-away-at-89**.

83. Ibid.

84. "Guns and Coders," BBC Radio 4, July 17, 2017, 0:26–1:43, **http://www.bbc.co.uk/programmes/b08y02wy.**

85. "Safe Storage: Summary of Federal Law," Giffords Law Center to Prevent Gun Violence, accessed October 25, 2017, **http://lawcenter.giffords.org/gun-laws/policy-areas/child-consumer-safety/safe-storage/#federal**.

86. *See* "Biometric Gun Safes," Walmart, accessed October 17, 2017, **https://www.walmart.com/c/kp/biometric-gun-safes**.

87. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," *Crain's Detroit (MI) Business*, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock.**

88. Dean Takahashi, "Charlie Walton, Inventor of RFID, Passes Away at 89," *Venture Beat*, November 27, 2011, **https://venturebeat.com/2011/11/27/charlie-walton-inventor-of-rfid-passes-away-at-89**.

89. *See* Tony Borroz, "Strapping Success: The 3-Point Seat belt Turns 50," *Wired*, August 13, 2009, **https://www.wired.com/2009/08/strapping-success-the-3-point-seat belt-turns-50**.

90. Ibid.

91. Susan Gilbert, "Child-Resistant Medicine Caps Do Save Lives," *New York Times*, June 5, 1996, **http://www.nytimes.com/1996/06/05/us/child-resistant-medicine-caps-do-save-lives.html**. These gains were projected to increase after child-resistant packages were redesigned in 1998 to be easier for adults to use, but no easier for children to open (which helped ensure that more people, particularly elderly individuals, used the child-resistant packages).

92. *See* Greg Schneider, "Car Window Deaths Anger Safety Groups," *Washington Post*, June 24, 2004, **https://www.washingtonpost.com/archive/politics/2004/06/24/car-window-deaths-anger-safety-groups/cb606de3-27c1-4ca9-be03-9f1d33d54bd1**.

93. "Timothy Daniel, 17-Year-Old Student, Takes His Life With a Gun," *Flagler Live*, July 25, 2017, **https://flaglerlive.com/110515/timothy-daniel**.

94. Ibid.

95. Ibid.

96. *Confronting the Inevitability Myth: How Data-Driven Gun Policies Save Lives from Suicide,* Law Center to Prevent Gun Violence (September 2017), 12, 23–24, **http://lawcenter.giffords.org/wp-content/uploads/2017/10/Confronting-The-Inevitability-Myth.pdf**.

97. Lauren Marcy, "Preventing Teen Suicide: When to Remove Firearms from Your Home," *University of Michigan Children's Health Blog*, March 23, 2018, **https://healthblog.uofmhealth.org/childrens-health/preventing-teen-suicide-when-to-remove-firearms-from-your-home**.

98. "Duration of Suicidal Crises," Harvard TH Chan School of Public Health, Means Matter, accessed Jan. 23, 2018, **https://www.hsph.harvard.edu/means-matter/means-matter/duration** (citing Thomas R. Simon, et al., "Characteristics of Impulsive Suicide Attempts and Attempters," Suicide and Life Threatening Behavior 32, no. 1 (supplement) (2001)).

99. *See Confronting the Inevitability Myth: How Data-Driven Gun Policies Save Lives from Suicide,* Law Center to Prevent Gun Violence (September 2017), 25, **http://lawcenter.giffords.org/wp-content/uploads/2017/10/Confronting-The-Inevitability-Myth.pdf**.

100. Lauren Marcy, "Preventing Teen Suicide: When to Remove Firearms from Your Home," *University of Michigan Children's Health Blog*, March 23, 2018, **https://healthblog.uofmhealth.org/childrens-health/preventing-teen-suicide-when-to-remove-firearms-from-your-home**.

101. *Confronting the Inevitability Myth: How Data-Driven Gun Policies Save Lives from Suicide,* Law Center to Prevent Gun Violence (September 2017), 30, **http://lawcenter.giffords.org/wp-content/uploads/2017/10/Confronting-The-Inevitability-Myth.pdf**.

102. Ibid., 19.

103. Elizabeth Van Brocklin, "19 Children Are Shot in America Every Day," *The Trace*, June 19, 2017, **https://www.thetrace.org/2017/06/19-children-shot-america-every-day-cdc-study**.

104. *See* Daniel W. Webster et al., *Firearms on College Campuses: Research Evidence and Policy Implications* (Baltimore: Johns Hopkins Bloomberg School of Public Health, 2016), 18–19, **https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-gun-policy-and-research/_pdfs/GunsOnCampus.pdf**.

105. "Fatal Injury Data and Non-Fatal Injury Data," Centers for Disease Control and Prevention, Web-based Injury Statistics Query and Reporting System (WISQARS), accessed May 17, 2017, **https://www.cdc.gov/injury/wisqars**.

106. Ibid.

107. David Owens, Judith Horrocks, and Allan House, "Fatal and Non-Fatal Repetition of Self-Harm: Systematic Review," British Journal of Psychiatry 181, no. 3 (2002): 193–199; *see also* "Attempters' Longterm Survival," Harvard TH Chan School of Public Health, Means Matter, **http://www.hsph.harvard.edu/means-matter/means-matter/survival**.

108. "Fatal Injury Data and Non-Fatal Injury Data," Centers for Disease Control and Prevention, Web-based Injury Statistics Query and Reporting System (WISQARS), accessed December 23, 2016, **https://www.cdc.gov/injury/wisqars**.

109. Ibid.

110. American Academy of Pediatrics, "Policy Statement: Firearm-Related Injuries Affecting the Pediatric Population," *Journal of Pediatrics* 130, no. 5 (Nov. 2012): e1416.

111. *See* Michael Hiltzik, "Aiming to Bring Smart Guns to U.S. Market," *Los Angeles Times*, December 11, 2015, **http://www.latimes.com/business/hiltzik/la-fi-hiltzik-20151213-column.html** (quoting Stephen Teret of Johns Hopkins University).

112. *See* "Youth Access to Firearms," Harvard TH Chan School of Public Health, Means Matter, accessed Jan. 23, 2018, **https://www.hsph.harvard.edu/means-matter/means-matter/youth-access** (82% of gun suicides by minors 17 and younger were committed with a family member's gun).

113. *See* Andrew Anglemyer, Tara Horvath, and George Rutherford, "The Accessibility of Firearms and Risk for Suicide and Homicide Victimization Among Household Members: A Systematic Review and Meta-analysis," *Annals of Internal Medicine* 160, no. 2, (Jan. 2014): 101–110, doi:10.7326/M13-1301.

114. Mike Kelly, "A Teen's Suicide and the Battle to Confiscate his Father's Firearms," *North Jersey Record*, April 6, 2018, **https://www.northjersey.com/story/news/columnists/mike-kelly/2018/04/06/teens-suicide-battle-confiscate-his-fathers-firearms/479427002**.

115. *See* "Risk Factors and Warning Signs," American Foundation for Suicide Prevention, accessed January 22, 2018, **https://afsp.org/aboutsuicide/risk-factors-and-warning-signs**.

116. "Suicide Prevention—Suicide Statistics," Mental Health America, accessed September 9, 2017, **http://www.mentalhealthamerica.net/suicide**.

117. "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 1:16–2:52, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2.**

118. Ibid.

119. "Protect Children Not Guns," Children's Defense Fund (July 24, 2013), 34, **http://www.childrensdefense.org/library/protect-children-not-guns/protect-children-not-guns-2013.pdf**.

120. Christopher Ingraham, "People Are Getting Shot by Toddlers on a Weekly Basis this Year, Wonkblog, *Washington Post*, October 14, 2015; Christopher Ingraham, "American Toddlers are Still Shooting People on a Weekly Basis this Year," Wonkblog, *Washington Post*, September 29, 2017.

121. Deborah Azrael, Joanna Cohen, Carmel Salhi, and Matthew Miller, "Firearm Storage in Gun-owning Households with Children: Results of a 2015 National Survey." *Journal of Urban Health* (2018): 1–10.

122. Frances Baxley and Matthew Miller, "Parental Misperceptions About Children and Firearms," *Archives of Pediatric and Adolescent Medicine* 160, no. 5 (May 2006): 542, doi:10.1001/archpedi.160.5.542.

123. Ibid.

124. The researchers concluded that "[p]arents who locked their guns away and discussed gun safety with their children were as likely to be contradicted as parents who did not take such safety measures." Ibid.

125. "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 32:50, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2** (interview with Deborah Azrael).

126. "My Kid Would Never Do That: Gun Safety," *Dateline*, NBC, June 21, 2016, **https://www.nbcnews.com/dateline/video/my-kid-would-never-do-that--gun-safety-472914499953**.

127. Ibid.

128. Kerry Shaw, "This Detroit DA is Willing to Prosecute Grieving Parents After Kids Die in Gun Accidents," *The Trace*, May 25, 2017, **https://www.thetrace.org/2017/05/gun-safety-kids-prosecute-parents-accidental-shootings** (quoting Wayne County District Attorney Kym Worthy).

129. Stephen P. Teret and Adam D. Mernit, "Personalized Guns: Using Technology to Save Lives," in *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013), 175; *see also* Philip J. Cook, Stephanie Molliconi, Thomas B. Cole, "Regulating Gun Markets," *Journal of Criminal Law and Criminology* 86, no. 1 (Fall 1995). More conservative estimates gathered by ATF in 2012, which include only gun thefts or losses where a police report was filed, still showed over 170,000 firearms were stolen that year from private individuals. Bureau of Alcohol, Tobacco, Firearms and Explosives, "2012 Summary: Firearms Reported Lost or Stolen" (June 2013), 4, **https://www.atf.gov/sites/default/files/assets/Firearms/2012-summary-firearms-reported-lost-and-stolen-2.pdf** (individuals reported the loss or theft of more than 173,000 guns nationwide in 2012).

130. Stephen P. Teret and Adam D. Mernit, "Personalized Guns: Using Technology to Save Lives," in *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013), 175.

131. Frank Miniter, "Inside the Black Market for Guns," *Forbes*, August 12, 2016, **https://www.forbes.com/sites/frankminiter/2014/08/12/inside-the-black-market-for-guns**.

132. Laura Morel, "Unlocked and Loaded," *Tampa Bay Times*, November 1, 2017, **http://www.tampabay.com/projects/2017/special-report/unlocked-loaded/stolen-guns**.

133. Ibid. (Quoting detective from Jacksonville's car burglary task force, who stated that leaving a gun in an unlocked car "opens the realm to so many other crimes… We'll have guns stolen, which leads to robberies, which leads to homicides, which leads to shootings… If we could just eliminate vehicles being left unlocked, we eliminate a very high crime rate.").

134. Dan Noyes, "How Criminals Get Guns," *Frontline*, PBS, **http://www.pbs.org/wgbh/pages/frontline/shows/guns/procon/guns.html**.

135. Arthur L. Kellerman et al., "Injuries and Deaths Due to Firearms in the Home," *Journal of Trauma, Injury, Infection, and Critical Care* 45, no. 2 (August 1998): 266; Linda L. Dahlberg, Robin M. Ikeda, and Marcie-jo Kresnow, "Guns in the Home and Risk of a Violent Death in the Home: Findings from a National Study," *American Journal of Epidemiology* 160, no. 10 (November 2004): 935, doi:10.1093/aje/kwh309.

136. Charles C. Branas et al., "Investigating the Link Between Gun Possession and Gun Assault," *American Journal of Public Health* 99, no. 11 (November 2009): 2034, **http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2759797/pdf/2034.pdf**.

137. Federal Bureau of Investigation, Uniform Crime Reporting Program, "Law Enforcement Officers Killed and Assaulted 2014," Table 15, accessed May 9, 2018, **https://ucr.fbi.gov/leoka/2014/tables/table_15_leos_fk_victim_officers_weapon_stolen_by_offender_2005-2014.xls**.

138. Greg Suhr, interview by Lesley Stahl, *60 Minutes: Overtime*, CBS, November 1, 2015, **https://www.cbsnews.com/news/sf-police-chief-smart-guns-are-no-brainer**.

139. "Ranger Testifies on Theft of Gun Used In Kate Steinle Shooting at San Francisco's Pier 14," ABC 7 News, October 26, 2017, **http://abc7news.com/ranger-testifies-on-theft-of-gun-used-in-steinle-shooting-in-sf/2571467**.

140. Kelly Wright, "Courtroom Gasps as Video of Kate Steinle's Shooting is Played for Jury," Fox News, October 25, 2017, **http://www.foxnews.com/us/2017/10/25/kate-steinle-trial-to-feature-testimony-from-cop-who-responded-to-scene.html**.

141. Alene Tchekmedyian, "He Was Killed with an Immigration Agent's Stolen Weapon. Now, His Family is Suing ICE for Wrongful Death," *Los Angeles Times*, August 3, 2017, **http://www.latimes.com/local/lanow/la-me-ln-ice-gun-20170803-story.html**.

142. Henry Lee, "Thefts of Officers' Guns Raise Questions About Firearm Security," *San Francisco Chronicle*, August 29, 2015, **http://www.sfchronicle.com/crime/article/Thefts-of-officers-guns-raise-questions-about-6473661.php**; Eve Batey, "Another Day, Another Cop Has His Gun Stolen From His Car In SF," *SFist*, October 20, 2015, **http://sfist.com/2015/10/20/smh_smh_smh.php**.

143. Benny Evangelista, "Smart Gun Industry May Have Found Its Test Bed—San Francisco," *SFGate*, February 24, 2016, **http://www.sfgate.com/business/article/Smart-gun-industry-may-have-found-its-test-bed-6850142.php**.

144. Ibid.

145. *See* DR Weiss, Smart Gun Technology Project Final Report, report prepared for the US Department of Energy and the National Institute of Justice (Albuquerque, NM: Sandia National Laboratories, May 1996), **http://prod.sandia.gov/techlib/access-control.cgi/1996/961131.pdf**; John W. Wirsbinski, "'Smart Gun' Technology Update" (Albuquerque, NM: Sandia National Laboratories, November 2001), **http://prod.sandia.gov/techlib/access-control.cgi/2001/013499.pdf**.

146. US Department of Justice, National Institute of Justice, "Baseline Specifications for Law Enforcement Service Pistols with Security Technology" (Washington DC: US Department of Justice, Office of Justice Programs, 2016), **https://www.ncjrs.gov/pdffiles1/nij/250377.pdf**.

147. *See* Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 24–27, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf**.

148. Donald Sebastian, "The Conversation: What Makes a 'Smart Gun' Smart?," *Scientific American* (reprinted from *The Conversation*), January 11, 2016, **https://www.scientificamerican.com/article/the-conversation-what-makes-a-smart-gun-smart**.

149. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 13, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf**; *see also* Nicholas Kristof, "Smart Guns Save Lives. So Where Are They?," *New York Times*, January 17, 2015, **https://www.nytimes.com/2015/01/18/opinion/sunday/nicholas-kristof-smart-guns-save-lives-so-where-are-they.html**; Frank Miniter, "The Smart-Gun Maker Who Told Holder Off," *National Review*, August 11, 2014, **http://www.nationalreview.com/article/385109/smart-gun-maker-who-told-holder-frank-miniter** (one smart gun developer worked with Department of Defense–grade biometrics to develop a fingerprint scanner adapted to work through sweat and blood).

150. For example, federal specifications for law enforcement firearms specify that during testing, there may be up to five malfunctions per 600 rounds of ammunition shot (a malfunction rate of 1 in 120). National Institute of Justice Law Enforcement and Corrections Standards and Testing Program, "Autoloading Pistols for Police Officers: NIJ Standard-0112.03 Revision A" (July 1999), 7, **https://www.justnet.org/pdf/NIJSTD011203REVA.pdf**. *See also* Donald Sebastian, "The Conversation: What Makes a 'Smart Gun' Smart?," *Scientific American* (reprinted from *The Conversation*), January 11, 2016, **https://www.scientificamerican.com/article/the-conversation-what-makes-a-smart-gun-smart**; "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 24:20, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2** (discussing traditional firearms with higher failure rates than personalized gun being developed by Jonathan Mossberg).

151. Donald Sebastian, "The Conversation: What Makes a 'Smart Gun' Smart?," *Scientific American* (reprinted from *The Conversation*), January 11, 2016, **https://www.scientificamerican.com/article/the-conversation-what-makes-a-smart-gun-smart**; Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 26–27, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf**.

152. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 50, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf**.

153. Donald Sebastian, "The Conversation: What Makes a 'Smart Gun' Smart?," *Scientific American* (reprinted from *The Conversation*), January 11, 2016, **https://www.scientificamerican.com/article/the-conversation-what-makes-a-smart-gun-smart**.

154. Ibid.

155. Kelly Heyboer, "What is a 'Smart Gun' and Why Don't We Have One?," NJ.com, January 11, 2016, **http://www.nj.com/news/index.ssf/2016/01/president_obama_wants_a_smart_gun_njit_has_one_in.html**.

156. *See* "Safe Storage: Summary of Federal Law," Giffords Law Center to Prevent Gun Violence, accessed October 25, 2017, **http://lawcenter.giffords.org/gun-laws/policy-areas/child-consumer-safety/safe-storage/#federal;**

157. Tracy Connor, "'I'm Sorry': Mom Recounts Moment 5-Year-Old Shot and Killed Baby," NBC News, January 21, 2015, **http://www.nbcnews.com/news/investigations/im-sorry-mom-recountsmoment-5-year-old-shot-killed-n289541**.

158. *See*, e.g., Jackson v. City and County of San Francisco, 746 F.3d 953 (9th Cir. 2014) (the delay imposed by a law requiring that handguns be stored in a locked container or equipped with a trigger lock is only "a few seconds").

159. *See* "Profile of Timmy Oh," Smart Tech Challenges Foundation, accessed August 14, 2017, **https://smarttechfoundation.org/smart-firearms-technology/timmy-oh**.

160. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," *Crain's Detroit (MI) Business*, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock.**

161. Donald Sebastian, "The Conversation: What Makes a 'Smart Gun' Smart?," *Scientific American* (reprinted from *The Conversation*), January 11, 2016, **https://www.scientificamerican.com/article/the-conversation-what-makes-a-smart-gun-smart**.

162. *See* National Institute of Justice Law Enforcement and Corrections Standards and Testing Program, "Autoloading Pistols for Police Officers: NIJ Standard-0112.03 Revision A" (July 1999), 7, **https://www.justnet.org/pdf/NIJSTD011203REVA.pdf**; "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 24:20, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2** (discussing traditional firearms with higher failure rates than personalized gun being developed by Jonathan Mossberg).

163. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 24–25, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf.**

164. Ibid., 25.

165. Ibid.

166. Ibid.

167. "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 35:50, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2.**

168. Merrit Kennedy, "Wisconsin Company Offers To Implant Chips In Its Employees," NPR, July 25, 2017, **http://www.npr.org/sections/thetwo-way/2017/07/25/539265157**.

169. Ibid.

170. *See* Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 24–25, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf.**

171. "Zore X Core," Zore, accessed Jan. 30, 2018, **https://www.zore.life/zore-x-core**.

172. Ibid.

173. "Profile of Chris Herr," Smart Tech Challenges Foundation, accessed August 14, 2017, **https://smarttechfoundation.org/smart-firearms-technology/chrisherr**.

174. Ibid.

175. "GunVault Biometric Safe," Cabela's, accessed September 9, 2017, **http://www.cabelas.com/product/GunVault-Biometric-Safe/734827.uts**.

176. "Vaultek Biometric Safes," Vaultek, accessed October 23, 2017, **https://vaulteksafe.com**.

177. "Safe Storage. Quick Access. The Most Innovative Gun Safes on the Planet," The Gun Box, accessed October 23, 2017, **https://www.thegunbox.com**.

178. "SentrySafe Pistol Safe: Quick Access Biometric Gun Safe," Walmart, accessed September 9, 2017, **https://www.walmart.com/ip/SentrySafe-Pistol-Safe-Quick-Access-Biometric-Gun-Safe-Single-Gun-Capacity-QAP1BE/36613273**.

179. "Verifi Smart.Safe. Fast Access Biometric Safe with FBI Fingerprint Sensor," Amazon.com, accessed September 9, 2017, **https://www.amazon.com/Verifi-Smart-Safe-Access-Biometric-Fingerprint/dp/B0112OZH2I**.

180. "Quick-Access Biometric Gun Safes by BARSKA," BARSKA, accessed October 27, 2017, **https://www.barska.com/safes-security/biometric-safes.html**.

181. "GunVault Biometric Safe: Customer Reviews," Cabela's, accessed October 27, 2017, **http://www.cabelas.com/product/GunVault-Biometric-Safe/734827.uts**.

182. "RAPiD Safe," Hornady Security, accessed January 28, 2018, **https://www.hornady.com/security/rapid-safes**.

183. "Echo RFID Keypad," The Gun Box, accessed January 28, 2018, **https://www.thegunbox.com/products/echo-rfid-keypad**.

184. "Defender RFID Handgun Safe," Winchester Safes, accessed January 28, 2018, **https://winchestersafes.com/product/defender-rfid-handgun-safe**.

185. "Identilock FAQs—Fit Guide," Identilock, accessed September 9, 2017, **https://getidentilock.com/apps/help-center**.

186. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," *Crain's Detroit (MI) Business*, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock**; Mark Wallace, "How Young

Entrepreneurs Are Devising Tech Solutions To Gun Violence," *Fast Company*, March 23, 2018, **https://www.fastcompany.com/40548305/how-young-entrepreneurs-are-devising-tech-solutions-to-gun-violence**.

187. Kieron Monks, "The Guns That Know Who is Firing Them: Can Smart Tech Make Firearms Safer?," CNN, March 26, 2014, **http://www.cnn.com/2014/03/26/tech/innovation/smart-guns-know-whos-firing/index.html**; Darrell Hartman, "Can This High-Tech Gun Accessory Make Smart Guns A Reality?," *Fast Company*, January 11, 2016, **https://www.fastcompany.com/3054921/can-this-high-tech-gun-accessory-make-smart-guns-a-reality**.

188. Hilary Brueck, "This New Fingerprinting Technology Can Secure Almost Any Handgun," *Fortune*, January 14, 2016, **http://fortune.com/2016/01/14/identilock-gun-lock-sentinl**.

189. Doug Bolton, "Could Controversial 'Smart Gun' Technology Be the Cure to America's Gun Violence Epidemic?," January 13, 2016, *Independent*, **http://www.independent.co.uk/life-style/gadgets-and-tech/news/smart-gun-technology-obama-violence-safety-a6809596.html**.

190. Stan Jastrzebksi, "Safety Product That Uses Fingerprint ID Likely To Irk Some Gun Owners," *Morning Edition*, NPR, June 22, 2016, **http://www.npr.org/2016/06/22/483046632/safety-product-that-uses-fingerprint-id-likely-to-irk-some-gun-owners**; Hilary Brueck, "This New Fingerprinting Technology Can Secure Almost Any Handgun," *Fortune*, January 14, 2016, **http://fortune.com/2016/01/14/identilock-gun-lock-sentinl**; Kieron Monks, "The Guns That Know Who is Firing Them: Can Smart Tech Make Firearms Safer?," CNN, March 26, 2014, **http://www.cnn.com/2014/03/26/tech/innovation/smart-guns-know-whos-firing/index.html**.

191. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," *Crain's Detroit (MI) Business*, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock.**

192. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 57-60, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf.**

193. Lucas Mearian, "German Arms Maker Armatix to Release Second Smart Gun in US," *Computerworld*, October 19, 2016, **https://www.computerworld.com/article/3132572/emerging-technology/german-arms-maker-armatix-to-release-second-smart-gun-in-u-s.html.**

194. Andy Greenberg, "Anybody Can Fire This 'Locked' Smart Gun With $15 Worth of Magnets," *Wired*, July 24, 2017, **https://www.wired.com/story/smart-gun-fire-magnets**.

195. Ibid.

196. Michael S. Rosenwald, "Maryland Dealer, Under Pressure from Gun-Rights Activists, Drops Plan to Sell Smart Gun," *Washington Post*, May 2, 2014; Jeremy W. Peters, "'Smart' Firearm Draws Wrath of the Gun Lobby," *New York Times*, April 27, 2014, **https://www.nytimes.com/2014/04/28/us/politics/smart-firearm-draws-wrath-of-the-gun-lobby.html**.

197. N.J. Stat. Ann. § 2C:39-1dd; N.J. Stat. Ann. § 2C:58-2a(5)(e).

198. Michael S. Rosenwald, "Maryland Dealer, Under Pressure from Gun-Rights Activists, Drops Plan to Sell Smart Gun," *Washington Post*, 2, 2014; *see also* Jeremy W. Peters, "'Smart' Firearm Draws Wrath of the Gun Lobby," *New York Times*, April 27, 2014, **https://www.nytimes.com/2014/04/28/us/politics/smart-firearm-draws-wrath-of-the-gun-lobby.html**.

199. Michael S. Rosenwald, "Maryland Dealer, Under Pressure from Gun-Rights Activists, Drops Plan to Sell Smart Gun," *Washington Post*, 2, 2014.

200. John Rudolf, "Smith & Wesson Broke Clinton-Era Gun Safety Pledge To Boost Profits," *Huffington Post*, December 23, 2012, **https://www.huffingtonpost.com/2012/12/21/smith-wesson-clinton-bush-nra_n_2348503.html**.

201. Sarah Childress, "What Happened When a Major Gun Company Crossed the NRA," *Frontline*, PBS, January 16, 2005, 3:40–5:18, **https://www.pbs.org/wgbh/frontline/article/what-happened-when-a-major-gun-company-crossed-the-nra**.

202. Attorney General of New Jersey, *Attorney General's Report to the Governor and the Legislature as to the Availability of Personalized Handguns for Retail Sales Purposes, Pursuant to N.J.S. 2C:58-2.3* (November 2014), **http://www.njleg.state.nj.us/opi/Reports_to_the_Legislature/attorney_general_personalized_handgun_retail_report_Nov_2014.pdf**.

203. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 15, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf**.

204. Sarah Childress, "What Happened When a Major Gun Company Crossed the NRA," *Frontline*, PBS, January 16, 2005, 3:15, **https://www.pbs.org/wgbh/frontline/article/what-happened-when-a-major-gun-company-crossed-the-nra**.

205. Ibid., 3:40–5:18.

206. *See* "'Smart' Guns and Personalized Firearms," NRA-ILA Institute for Legislative Action, accessed May 10, 2018, **https://www.nraila.org/get-the-facts/smart-gunspersonalized-firearms**.

207. Frank Miniter, "The Smart-Gun Maker Who Told Holder Off," *National Review*, August 11, 2014, **http://www.nationalreview.com/article/385109/smart-gun-maker-who-told-holder-frank-miniter** (observing that "digital technology isn't what [manufacturers] do").

208. Mark Dewey, "A New 'Smart Rifle' Decides When to Shoot and Rarely Misses," NPR: *All Things Considered*, May 15, 2013, **https://www.npr.org/sections/alltechconsidered/2013/05/15/184223110/new-rifle-on-sale**.

209. Ibid.

210. Ibid.

211. *See* B. Gil Horman, "The Basics of Laser Sights," American Rifleman, September 19, 2011, **https://www.americanrifleman.org/articles/2011/9/19/the-basics-of-laser-sights**.

212. Joe Garofoli, "Can Tech Really Disrupt Gun Violence?" *San Francisco Chronicle*, January 9, 2016, **http://www.sfchronicle.com/business/article/can-tech-really-disrupt-gun-violence-6748327.php.**

213. Geoffrey A. Fowler, "A 19-Year-Old Just Built the First Fingerprint-Reading Smart Gun," *Wall Street Journal*, Oct. 7, 2016, **http://archive.is/PDMe8#selection-3887.0-3887.64**.

214. Ibid.

215. Lucas Mearian, "Efforts to Restart Smart-Gun Innovation Could Misfire Again," *Computerworld*, October 14, 2016, **https://www.computerworld.com/article/3131068/emerging-technology/efforts-to-restart-smart-gun-innovation-could-misfire-again.html**.

216. Ibid.

217. Nicholas Kristof, "Smart Guns Save Lives. So Where Are They?," *New York Times*, January 17, 2015, **https://www.nytimes.com/2015/01/18/opinion/sunday/nicholas-kristof-smart-guns-save-lives-so-where-are-they.html;** *see also* National Institute of Justice Law Enforcement and Corrections Standards and Testing Program, "Autoloading Pistols for Police Officers: NIJ Standard-0112.03 Revision A" (July 1999), 7, **https://www.justnet.org/pdf/NIJSTD011203REVA.pdf**; "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 24:20, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2**.

218. Geoffrey A. Fowler, "A 19-Year-Old Just Built the First Fingerprint-Reading Smart Gun," *Wall Street Journal*, Oct. 7, 2016, **http://archive.is/PDMe8#selection-3887.0-3887.64**.

219. Ibid.

220. *See* ibid.

221. Lucas Mearian, "Efforts to Restart Smart-Gun Innovation Could Misfire Again," *Computerworld*, October 14, 2016, **https://www.computerworld.com/article/3131068/emerging-technology/efforts-to-restart-smart-gun-innovation-could-misfire-again.html**; Mark Wallace, "How Young Entrepreneurs Are Devising Tech Solutions to Gun Violence," *Fast Company*, March 23, 2018, **https://www.fastcompany.com/40548305/how-young-entrepreneurs-are-devising-tech-solutions-to-gun-violence**.

222. Ibid.

223. Ibid.

224. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 40–41, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf.**

225. Ibid.

226. Lucas Mearian, "Efforts to Restart Smart-Gun Innovation Could Misfire Again," *Computerworld*, October 14, 2016, **https://www.computerworld.com/article/3131068/emerging-technology/efforts-to-restart-smart-gun-innovation-could-misfire-again.html**.

227. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 41, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf.**

228. Ibid., 42.

229. Josh Harkinson, "Welcome to the Future of Gun Control," *Mother Jones*, March/April 2016, **http://www.motherjones.com/politics/2016/02/smart-guns-mossberg-igun-venture-capital-conway**.

230. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 39, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf** (in 2013, iGun was "commercializable").

231. Dustin Walsh, "Cabela's Deal Gives Startup Jump on Sales for Fingerprint Trigger Lock," Crain's Detroit (MI) Business, July 14, 2017, **http://crainsdetroit.com/article/20170709/news/633451/cabelas-deal-gives-startup-jump-sales-fingerprint-trigger-lock**. Subsequent text references to the Identilock are also drawn from this source.

232. "Profile of Timmy Oh," Smart Tech Challenges Foundation, accessed August 14, 2017, **https://smarttechfoundation.org/smart-firearms-technology/timmy-oh**.

233. Ibid.

234. Ibid.

235. Jessica Hullinger, "Whatever Happened to that So-Called 'Smart Gun'?," *Fast Company*, January 5, 2016, **https://www.fastcompany.com/3054710/whatever-happened-to-that-so-called-smart-gun**.

236. "Profile of Rob Harvey and Will Murphy," Smart Tech Challenges Foundation, accessed August 20, 2017, **https://smarttechfoundation.org/smart-firearms-technology/will-murphy-rob-harvey**.

237. "Here's a Safe Gun Device that Does Exactly What It's Supposed to Do: Make a Gun Safe," *Mike the Gun Guy*, May 23, 2015, **https://mikethegunguy.com/tag/gun-guardian**.

238. Beyond the profiled companies, at least two other designs for personalized guns are currently in development. Armatix and LodeStar, a new company based in Philadelphia, have both announced plans to develop 9-millimeter pistols employing RFID technology. *See* Lucas Mearian, "German Arms Maker Armatix to Release Second Smart Gun in US," *Computerworld*, October 19, 2016, **https://www.computerworld.com/article/3132572/emerging-technology/german-arms-maker-armatix-to-release-second-smart-gun-in-u-s.html**; Erin Arvedlund,"Main Line Start-Up LodeStar Firearms Aims to Sell First US 'Smart Guns' by 2019," *Philadelphia Inquirer*, January 24, 2018, **http://www.philly.com/philly/business/philly-start-up-lodestar-firearms-aims-to-sell-smart-guns-2019-20180124.html**.

239. "'Smart' Guns and Personalized Firearms," NRA-ILA Institute for Legislative Action, accessed September 12, 2017, **https://www.nraila.org/get-the-facts/smart-gunspersonalized-firearms**.

240. "NSSF Statement on White House 'Smart Gun' Initiative," National Shooting Sports Foundation, accessed September 12, 2017, **https://www.nssf.org/nssf-statement-on-white-house-smart-gun-initiative**.

241. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

242. *See* "Smart Guns, Dumb Survey," National Shooting Sports Foundation, February 1, 2016, **https://www.nssf.org/smart-guns-dumb-survey** (referencing and linking to survey with 14% figure, available here: **http://71.11.3.134/share/pdf/national_smart_gun_final_stats.pdf**).

243. Michael Addady, "A Tiny Percentage of US Adults Own Half the Country's Guns," Fortune, September 19, 2016, **http://fortune.com/2016/09/19/us-gun-ownership**.

244. N.J. Stat. Ann. §§ 2C:58-2.3 et seq., 2C:39-1dd.

245. N.J. Stat. Ann. § 2C:39-1dd.

246. *See* Shawn Hamilton, "Here's What Happens When You Try to Make or Sell a 'Safer' Gun," *Huffington Post*, December 19, 2016, **https://www.huffingtonpost.com/entry/smart-guns-backlash_us_55e5d22ce4b0c818f61933a9**; Richard Pérez-Peña, "Gun Control Explained," *New York Times*, October 7, 2015, **https://www.nytimes.com/interactive/2015/10/07/us/gun-control-explained.html**.

247. Michael S. Rosenwald, "Maryland Dealer, Under Pressure from Gun-Rights Activists, Drops Plan to Sell Smart Gun," *Washington Post*, 2, 2014.

248. Joel Rose, "A New Jersey Law That's Kept Smart Guns Off Shelves Nationwide," *All Things Considered*, NPR, June 24, 2014, **https://www.npr.org/sections/alltechconsidered/2014/06/24/325178305/a-new-jersey-law-thats-kept-smart-guns-off-shelves-nationwide**.

249. Another impact is that manufacturers who were advocates for consumer choice—or aligned politically with the NRA—may have artificially limited the designs they considered. *See* Karen McVeigh, "Gun Control Groups Accuse New Jersey of Ignoring 'Smart Gun' Law," *Guardian*, May 21, 2014, **https://www.theguardian.com/world/2014/may/21/gun-control-new-jersey-smart-gun-law** (describing one prototype that "was designed specifically not to trigger the New Jersey law").

250. Alex Yablon, "New Jersey Legislators Reintroduce Smart Gun Reform, Putting Chris Christie Back on the Spot," *The Trace*, January 28, 2016, **https://www.thetrace.org/2016/01/new-jersey-smart-gun-reform-chris-christie**.

251. Susan K. Livio, "NJ 'Smart Gun' Bill Goes to Christie, Who Doesn't Like It," NJ.com, June 27, 2016, **http://www.nj.com/politics/index.ssf/2016/06/smart_gun_bill_goes_to_christie_who_is_likely_to_a.html**.

252. Md. Code Ann., Pub. Safety § 5-132.

253. Maryland Handgun Roster Board, *Sixteenth Annual Report on the Status of Personalized Handgun Technology*, July 1, 2017, **http://dlslibrary.state.md.us/publications/Exec/MDSP/PS5-132(d)(1)(ii)_2017.pdf**; Maryland Handgun Roster Board, *Fifteenth Annual Report on the Status of Personalized Handgun Technology*, July 1, 2016, **http://dlslibrary.state.md.us/publications/Exec/MDSP/PS5-132(d)(1)(ii)_2016.pdf**.

254. Mass. Gen. Laws ch. 140, §§ 131K. New Jersey also has a similar law that requires retail firearms dealers to include a trigger lock or a lockable container with every handgun sold, unless the handgun is on the state list of approved personalized handguns. N.J. Stat. Ann. § 2C:58-2a(5)(d), (e).

255. *See* "Approved Firearm Safety/Locking Devices," Massachusetts Executive Office of Public Safety and Security, accessed September 12, 2017, **http://www.mass.gov/eopss/firearms-reg-and-laws/firearm-safety-locking-devices.html**.

256. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

257. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 14–15, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf.**

258. Ibid.

259. Ibid., 15–17.

260. Ibid., 14–15.

261. *See* ibid.

262. Kelly Heyboer, "What is a 'Smart Gun' and Why Don't We Have One?," NJ.com, January 11, 2016, **http://www.nj.com/news/index.ssf/2016/01/president_obama_wants_a_smart_gun_njit_has_one_in.html**.

263. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

264. Leo Wolinsky, "Big Lobbies Clash in Fight on Seat Belts: Hearings Open Today as California Joins Auto Safety Debate," *Los Angeles Times*, February 19, 1985, **http://articles.latimes.com/1985-02-19/news/mn-546_1_seat-belts**.

265. Joe Garofoli, "Can Tech Really Disrupt Gun Violence?" *San Francisco Chronicle*, January 9, 2016, **http://www.sfchronicle.com/business/article/can-tech-really-disrupt-gun-violence-6748327.php.**

266. *See* ibid.

267. Ross Baird, *The Innovation Blind Spot: Why We Back the Wrong Ideas and What to Do About It* (Dallas: BenBella Books, Inc., 2017), 212, 248; Ross Baird, "Silicon Valley's Blind Spots Are Costing Venture Capitalists Huge Opportunities," Business Insider, September 11, 2017, **http://www.businessinsider.com/silicon-valley-venture-capital-missing-out-on-middle-of-america-2017-9**.

268. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041; Michael Addady, "A Tiny Percentage of US Adults Own Half the Country's Guns," Fortune, September 19, 2016, **http://fortune.com/2016/09/19/us-gun-ownership**.

269. Mark Follman et al., "The True Cost of Gun Violence in America: The Data the NRA Doesn't Want You to *See*.," *Mother Jones*, April 15, 2015, **https://www.motherjones.com/politics/2015/04/true-cost-of-gun-violence-in-america**.

270. Joe Garofoli, "Can Tech Really Disrupt Gun Violence?" *San Francisco Chronicle*, January 9, 2016, **http://www.sfchronicle.com/business/article/can-tech-really-disrupt-gun-violence-6748327.php.**

271. Ibid.

272. Elizabeth MacBride, "Why We Need to Look for Innovation Outside America and Its Elites," *Forbes*, September 30, 2017, **https://www.forbes.com/sites/elizabethmacbride/2017/09/30/6-reasons-to-worry-about-innovation-in-america**.

273. Chuck Salter, "Silicon Valley's Smart Tech Foundation Launches $1 Million Competition For Safer Guns," *Fast Company*, November 6, 2013, **https://www.fastcompany.com/3021232/silicon-valley-trio-launches-1-million-competition-for-smarter-safer-guns-exclusive**.

274. Jessica Hullinger, "Whatever Happened to that So-Called "Smart Gun"?," *Fast Company*, January 5, 2016, **https://www.fastcompany.com/3054710/whatever-happened-to-that-so-called-smart-gun**.

275. *See* 15 U.S.C. § 2052(a)(1)(ii)(E), referencing 26 U.S.C. § 4181.

276. "Gun Industry Immunity," Giffords Law Center to Prevent Gun Violence, accessed October 28, 2017, **http://lawcenter.giffords.org/immunity**.

277. *See* Sarah Childress, "What Happened When A Major Gun Company Crossed the NRA," *Frontline*, PBS, January 16, 2005, 3:40–5:18, **https://www.pbs.org/wgbh/frontline/article/what-happened-when-a-major-gun-company-crossed-the-nra**.

278. E.g., American Outdoor Brands Corporation, "American Outdoor Brands Corporation Issues Detailed Rebuttal to BlackRock," news release, March 6, 2018, **https://www.valuewalk.com/2018/03/american-outdoor-brands-corporation-issues-detailed-rebuttal-to-blackrock**.

279. Mark Dewey, "A New 'Smart Rifle' Decides When to Shoot and Rarely Misses," *All Things Considered*, NPR, May 15, 2013, **https://www.npr.org/sections/alltechconsidered/2013/05/15/184223110/new-rifle-on-sale**.

280. *See*, e.g., Joel Rose, "A New Jersey Law That's Kept Smart Guns Off Shelves Nationwide," *All Things Considered*, NPR, June 24, 2014, **https://www.npr.org/sections/alltechconsidered/2014/06/24/325178305/a-new-jersey-law-thats-kept-smart-guns-off-shelves-nationwide**.

281. Joe Garofoli, "Can Tech Really Disrupt Gun Violence?" *San Francisco Chronicle*, January 9, 2016, **http://www.sfchronicle.com/business/article/can-tech-really-disrupt-gun-violence-6748327.php**.

282. *See* Ibid.

283. E.g., Yuri Kageyama, "Hitachi Shows Off World's Smallest RFID Chip," Associated Press for NBC News, Feb. 22, 2017, **http://www.nbcnews.com/id/17284751/ns/technology_and_science-innovation/t/hitachi-shows-worlds-smallest-rfid-chip**; Patrick Moorhead, "Synaptics Shipping First In-Display Smartphone Fingerprint Reader with Vivo," *Forbes*, Dec. 14, 2017, **https://www.forbes.com/sites/patrickmoorhead/2017/12/14/synaptics-shipping-first-in-display-smartphone-fingerprint-reader-to-vivo**; Vlad Savov, "I Tried the World's First Phone with an In-Display Fingerprint Sensor," *Verge*, Jan. 9, 2018, **https://www.theverge.com/circuitbreaker/2018/1/9/16867536/vivo-fingerprint-reader-integrated-display-biometric-ces-2018**.

284. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi: 10.2105/AJPH.2015.303041.

285. *See*, e.g., "Without Significant New Investment in Innovation, Solar Energy's Growth Will Stall," Council on Foreign Relations, March 5, 2018, **https://www.cfr.org/news-releases/without-significant-new-investment-innovation-solar-energys-growth-will-stall**; Wei Jin and Zhong Xiang Zhang, "Explaining the Slow Pace of Energy Technological Innovation: Why Market Conditions Matter," (working paper no. 1401, Centre for Climate Economic & Policy, Crawford School of Public Policy, Australian National University, 2014), **https://ageconsearch.umn.edu/bitstream/249420/2/ccep1401.pdf**; Jean Baptiste Su, "Ford Admits Auto Industry Slow to Innovate," *Forbes*, June 27, 2013, **https://www.forbes.com/sites/jeanbaptiste/2013/06/27/ford-admits-auto-industry-slow-to-innovate-praises-silicon-valley-video**; see also David Pakman, "The Auto Industry Won't Create the Future," *Wired*, November 3, 2015, **https://www.wired.com/2015/11/the-auto-industry-wont-**

create-the-future (noting that "Cultures of rapid innovation, while common in technology, are less common in industrial age companies").

286. *See,* e.g., Leo Wolinsky, "Big Lobbies Clash in Fight on Seat Belts: Hearings Open Today as California Joins Auto Safety Debate," *Los Angeles Times*, February 19, 1985, **http://articles.latimes.com/1985-02-19/news/mn-546_1_seat-belts**.

287. *See*, e.g., "Seat Belt Use in US Reaches Historic 90%," National Highway Traffic Safety Administration, November 21, 2016, **https://www.nhtsa.gov/press-releases/seat-belt-use-us-reaches-historic-90-percent** (crediting federal legislation and policies, "including incentive grants and support for enforcement" of seat belt laws, for driving up rates of seat belt use).

288. *See* "'Smart' Guns and Personalized Firearms," NRA-ILA Institute for Legislative Action, accessed September 12, 2017, **https://www.nraila.org/get-the-facts/smart-gunspersonalized-firearms**; "NSSF Statement on White House 'Smart Gun' Initiative," National Shooting Sports Foundation, accessed September 12, 2017, **https://www.nssf.org/nssf-statement-on-white-house-smart-gun-initiative**.

289. "Economics Brief—Six Big Ideas: Externalities," *Economist*, August 19, 2017.

290. Ibid.

291. Ibid.

292. Mark Follman et al., "The True Cost of Gun Violence in America: The Data the NRA Doesn't Want You to See," *Mother Jones*, April 15, 2015, **https://www.motherjones.com/politics/2015/04/true-cost-of-gun-violence-in-america**.

293. "Economics Brief—Six Big Ideas: Externalities," *Economist*, August 19, 2017.

294. *See* Jaegul Lee, Francisco M. Veloso, and David A. Hounshell, "Innovation and Technology Policy: Lessons from Emission Control and Safety Technologies in the US Automobile Industry" (paper prepared for the Sloane Industry Studies Conference, April 2007), **http://web.mit.edu/sis07/www/lee.pdf**.

295. 26 U.S.C. § 41.

296. "Impact of the Orphan Drug Tax Credit on Treatments for Rare Diseases," Ernst and Young, (prepared by Biotechnology Industry Organization and the National Organization for Rare Disorders, June 2015), **https://www.bio.org/sites/default/files/EY%20BIO%20Orphan%20Drug%20Tax%20Credit%20Report%202015%2006%2016.pdf**.

297. "Manufacturers' Energy Efficient Appliance Credit," Internal Revenue Service, accessed August 26, 2017, **https://www.irs.gov/businesses/corporations/manufacturers-energy-efficient-appliance-credit**.

298. "Renewable Electricity Production Tax Credit (PTC)," Energy.gov, accessed August 26, 2017, **https://energy.gov/savings/renewable-electricity-production-tax-credit-ptc**.

299. *See* 32 V.S.A. § 5930w.

300. "SBIR/STTR Commercialization Readiness Pilot (CRP) Program," National Institutes of Health, accessed July 18, 2017, **https://grants.nih.gov/grants/guide/pa-files/PAR-16-026.html**.

301. *See* Mark Joseph Stern, "How to Make the Gun Industry Pay," Slate, November 6, 2017, **http://www.slate.com/articles/news_and_politics/jurisprudence/2017/11/a_special_tax_on_the_firearm_industry_is_the_only_way_to_make_victims_of.html** (discussing the viability of a state firearm industry tax).

302. 26 U.S.C. § 4181.

303. "Find Product Rebates and Other Offers," Energy Star, accessed July 15, 2017, **https://www.energystar.gov/rebate-finder**.

304. "Alternative Motor Vehicle Credit," Internal Revenue Service, accessed July 15, 2017, **https://www.irs.gov/newsroom/alternative-motor-vehicle-credit-1**.

305. Conn. General Stat. § 12-412(101); Mass. Gen. Laws ch. 64H, § 6(rr); N.J. Stat. Ann. §§ 54:32B-8.50 & 8.51.

306. Wash. Rev. Code § 82.08.832.

307. City of Northglenn, "Gun Safe Rebate Program," accessed January 28, 2018, **https://www.northglenn.org/gunsafe**.

308. Department of Transportation, National Highway Traffic Safety Administration, "Announcement of Grants for Child Passenger Protection Education", 66 Fed. Reg. 67625 (December 31, 2006), **https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/2003bannouncementsofgrants.pdf**.

309. Federal Highway Administration, "Fact Sheet: Alcohol-Impaired Driving Countermeasures Incentive Grants" (September 14, 1998), **https://www.fhwa.dot.gov/tea21/factsheets/n_410.htm**.

310. Nicholas Kristof, "Smart Guns Save Lives. So Where Are They?," *New York Times*, January 17, 2015, **https://www.nytimes.com/2015/01/18/opinion/sunday/nicholas-kristof-smart-guns-save-lives-so-where-are-they.html.**

311. Mark Greene, *National Institute of Justice Research Report: A Review of Gun Safety Technologies* (Washington DC: US Department of Justice, Office of Justice Programs, June 2013), 41, **https://www.ncjrs.gov/pdffiles1/nij/242500.pdf**.

SIDEBAR ENDNOTES

i. Aaron Davis et al., "The ATF-Approved 'Goofy Little Doodad' Used by Las Vegas Gunman Stephen Paddock," *Washington Post*, Oct. 4, 2017.

ii. Sam Petulla, "Here is 1 Correlation Between State Gun Laws and Mass Shootings," CNN, Oct. 5, 2017, **https://www.cnn.com/2017/10/05/politics/gun-laws-magazines-las-vegas/index.html** (noting that large-capacity magazines "tend to be used in the deadliest shootings").

iii. Mark Dewey, "A New 'Smart Rifle' Decides When to Shoot and Rarely Misses," *All Things Considered*, NPR, May 15, 2013, **https://www.npr.org/sections/alltechconsidered/2013/05/15/184223110/new-rifle-on-sale**.

iv. John Bresnahan, "Controversial Gun Silencer Measure Advances," *Politico*, September 13, 2017; Nick Wing, "Struggling Gun Industry Looks to Congress to Make Silencers the Next Big Thing," *Huffington Post*, Sep. 4, 2017, **https://www.huffingtonpost.com/entry/congress-gun-silencers-bill_us_59b95c08e4b0edff97188620**.

v. "Traffic Safety Facts: Children," Department of Transportation, National Highway Traffic Safety Administration (2018), **http://www-nrd.nhtsa.dot.gov/Pubs/811387.pdf**.

vi. Susan Gilbert, "Child-Resistant Medicine Caps Do Save Lives," *New York Times*, June 5, 1996, **http://www.nytimes.com/1996/06/05/us/child-resistant-medicine-caps-do-save-lives.html**.

vii. "Which Power-Window Switches are Safer? Check the Switches If You're Buying a Used Car," *Consumer Reports*, April 2014, **https://www.consumerreports.org/cro/2011/12/which-power-window-switches-are-safer/index.htm**.

viii. Deborah Azrael, Joanna Cohen, Carmel Salhi, and Matthew Miller, "Firearm Storage in Gun-owning Households with Children: Results of a 2015 National Survey." *Journal of Urban Health* (2018): 1–10.

ix. Fatal Injury Data and Non-Fatal Injury Data," Centers for Disease Control and Prevention, Web-based Injury Statistics Query and Reporting System (WISQARS), **https://www.cdc.gov/injury/wisqars**. 21,000 gun suicides represents a yearly average calculated from 2011 to 2015.

x. Stephen P. Teret and Adam D. Mernit, "Personalized Guns: Using Technology to Save Lives," in *Reducing Gun Violence in America*, ed. Daniel W. Webster and Jon S. Vernick (Baltimore: The Johns Hopkins University Press, 2013), 175.

xi. *See* Alma Cohen and Liran Einav, "The Effects of Mandatory Seat Belt Laws on Driving Behavior and Traffic Fatalities," (discussion paper, Olin Center for Law, Economics and Business, Harvard Law School, Cambridge, MA, 2011), 1–2, **http://www.law.harvard.edu/programs/olin_center/papers/pdf/341.pdf**.

xii. "A Smarter Gun," *Motherboard,* VICE Video, March 24, 2017, 7:30–9:03, **https://video.vice.com/en_us/video/a-smarter-gun/58406647464cde3c016db4b2**.

xiii. *See* sidebar on page 7 and endnotes i through iv.

xiv. Julia A. Wolfson et al., "The US Public's Preference for Safer Guns," *American Journal of Public Health* 106, no. 3 (March 2016): 412, doi:10.2105/AJPH.2015.303041.

xv. *See* Josh Harkinson, "Fully Loaded: Inside the Shadowy World of America's 10 Biggest Gunmakers," *Mother Jones*, June 14, 2016, **https://www.motherjones.com/politics/2016/06/fully-loaded-ten-biggest-gun-manufacturers-america**.

GIFFORDS
LAW CENTER
TO PREVENT GUN VIOLENCE

giffordslawcenter.org

EMAIL media@giffords.org

FACEBOOK /Giffords

TWITTER @GiffordsCourage

For 25 years, the legal experts at Giffords Law Center to Prevent Gun Violence have been fighting for a safer America by researching, drafting, and defending the laws, policies, and programs proven to save lives from gun violence. Founded in the wake of a 1993 mass shooting in San Francisco, in 2016 the Law Center joined with former Congresswoman Gabrielle Giffords to form a courageous new force for gun safety that stretches coast to coast.