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COMMENT

3D PRINTERS, OBSOLETE FIREARM SUPPLY CONTROLS, AND THE RIGHT TO BUILD SELF-DEFENSE WEAPONS UNDER *HELLER*

PETER JENSEN-HAXEL[*]

INTRODUCTION

> "Will the next war be armed with 3D printers? One thing that's for sure, the cat is out of the bag . . . ."[1]

Three-dimensional printers will allow people with no technical expertise to produce firearms at home. These machines,[2] employing a novel fabrication technique called additive manufacturing ("AM"), may seem alien, indeed miraculous.

> [I]magine doing this: designing shoes exactly the right size in the style and colour you want on a computer, or downloading a design from the web and customising it. Then press print and go off to have lunch

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[1] Bre Pettis, *Deadly Weapons on Thingiverse*, THINGIVERSE BLOG (Oct. 3, 2011), http://blog.thingiverse.com/2011/10/03/deadly-weapons-on-thingiverse/.

[2] For a fifteen-minute overview of 3D printing, see Lisa Harouni, *A Primer on 3D Printing*, TED (Jan. 2012), www.ted.com/talks/lisa_harouni_a_primer_on_3d_printing.html.

> while a device on your desk manufactures them for you. . . . [The technology] is not yet available. But it is getting close.[3]

This process works by depositing material layer-by-layer with a printer head, each layer fusing to create a three-dimensional object. The tiny factories can build previously impossible-to-construct shapes in a wide range of materials, from plastic to sugar, titanium to gold.[4]

Poised to spring from obscurity to universal recognition, 3D printers promise a new industrial revolution.[5] Additive manufacturing has the potential to drastically cut waste while expanding the number of products available to consumers.[6] It could bring manufacturing back to America, create more complex and efficient designs, revolutionize distribution, and break down economies of scale.[7]

As the power of production passes from industry to consumer, many areas of the law may be caught unprepared. Already, concerns over patent, copyright and trademark infringement have arisen.[8] But one area that will be caught completely caught off-guard is federal firearm regulation, a monolithic legal scheme erected with the belief that guns and gun components originate in industrial facilities. The advent of AM means that this foundational assumption is now fundamentally flawed.

This Comment describes how 3D printers will render current firearm regulations obsolete by allowing individuals to easily produce firearms—production that, when exercised by law-abiding citizens, may be protected under the Supreme Court's decision in *District of Columbia v. Heller*.[9] The regulatory system will be undermined in two phases. First, printers will be able to produce the only regulated piece of a

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[3] *A Factory on Your Desk*, ECONOMIST TECH. Q., Sept. 3, 2009, *available at* www.economist.com/node/14299512.

[4] Terry Wohlers, *Additive Manufacturing 101: Part I*, WOHLERSASSOCIATES.COM (Jan.-Feb. 2010), www.wohlersassociates.com/JanFeb10TC.htm (plastic); CANDYFAB.ORG, http://wiki.candyfab.org/ (last visited Apr. 1, 2012) (confectionaries); Terry Wohlers, *Additive Manufacturing 101: Part IV*, WOHLERSASSOCIATES.COM (July-Aug. 2010), www.wohlersassociates.com/JulAug10TC.htm (titanium and gold).

[5] Chris Anderson, *In the Next Industrial Revolution, Atoms Are the New Bits*, WIRED, Feb. 2010, *available at* www.wired.com/magazine/2010/01/ff_newrevolution.

[6] *Print Me a Stradivarius*, ECONOMIST, Feb. 10, 2011, at 11, *available at* www.economist.com/node/18114327 ("[3D printers reduce] waste enormously, requiring as little as one-tenth of the amount of material. . . . And because each item is created individually, rather than from a single mould, each can be made slightly different at almost no extra cost.").

[7] *Id.*

[8] *Id.*; Michael Weinberg, *It Will Be Awesome if They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology*, PUBLIC KNOWLEDGE, Nov. 2010, at 1, *available at* www.publicknowledge.org/it-will-be-awesome-if-they-dont-screw-it-up (explaining that intellectual property holders may clamor for 3D printer regulation due to the technology's copying capability).

[9] District of Columbia v. Heller, 554 U.S. 570 (2008).

firearm, the frame. Second, the printing of complete guns may be realized as 3D print technology advances or firearm design evolves. These developments, which could cause substantial changes in how both criminals and legitimate consumers obtain firearms, could lead to outright prohibition of personal manufacture or specific bans on weapons made by 3D printers. *District of Columbia v. Heller*, the Supreme Court's 2008 decision interpreting the Second Amendment as protecting an individual right to possess firearms, could be interpreted to constrain this particular regulatory response. Specifically, *Heller* may create a right for individuals to make their own weapons to be used in self-defense and may protect certain processes and materials involved in making firearms.

Part I introduces 3D printers and explains which gun components they can already produce. Part II explains how firearms are presumptively distributed under federal regulations, describes the structure of the firearm industry, and discusses theories on how consumers and criminals actually obtain guns. Part III explains how 3D printers may change the way firearms are acquired, undermining or even rendering obsolete the current regulatory system. Part IV, after outlining the constitutional right to bear arms, interprets *Heller* as supporting an individual right for law-abiding citizens to make their own self-defense weapons, and explains why this interest is legitimate. Part IV also analyzes the extent to which *Heller* may extend Second Amendment protection to weapons made by additive manufacturing. The Conclusion summarizes and stresses the importance of 3D printers remaining unrestricted, irrespective of their influence on self-defense.

I. TECHNOLOGY

A. THE RISE OF 3D PRINTERS—LAYER BY LAYER

> "[It's like having] China on your desktop."[10]

Three-dimensional printers produce objects using a technique called additive manufacturing.[11] The process begins with a digital 3D model

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[10] Adrian Bowyer, *RepRap*, VIMEO (Jan. 26, 2012), http://vimeo.com/5202148 (quoting Chris DiBona, Open Source Program Manager at Google, describing the RepRap 3D printer).

[11] Terry Wohlers, *Additive Manufacturing 101: Part I*, WOHLERSASSOCIATES.COM (Jan.-Feb. 2010), www.wohlersassociates.com/JanFeb10TC.htm ("ASTM International Committee F42 on Additive Manufacturing Technologies, an industry-led standards group, defines [the term Additive Manufacturing] as the process of joining materials to make objects from 3D model data, usually

created using Computer Added Design ("CAD") software.[12] The software automatically slices the model into a stack of thin horizontal cross-sections about 0.1mm in height.[13] The 3D printer then builds the physical model by depositing material layer by layer.[14] After a deposition head extrudes one layer in the horizontal plane, the head rises slightly and deposits the next slice.[15] Each layer fuses with the layer below it,[16] a process similar to "a pastry chef mak[ing] baklava with sheets of phyllo dough."[17] A second nozzle may deposit temporary scaffolding material to support overhanging and delicate parts.[18]

Additive manufacturing demonstrates enormous industrial advantage over conventional techniques, where parts are built by removing materials through cutting and grinding ("subtractive" manufacturing) or created through pseudo-additive processes such as injection molding.[19] AM is fast, requires only a single machine, [20] and has no need for expensive retooling with each new project or design modification.[21] It removes limitations on manufacturing complex curves and intricate cavities, and it bypasses the logistical challenges of clamping small and unusual work pieces.[22] Amazingly, AM simplifies

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layer upon layer, as opposed to subtractive manufacturing methodologies. Synonyms are additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, and freeform fabrication."). There are many variations of this overall technique. *See, e.g.*, Terry Wohlers, *Additive Manufacturing 101: Part IV*, WOHLERSASSOCIATES.COM, www.wohlersassociates.com/JulAug10TC.htm (direct powder deposition).

[12] Wohlers, *Additive Manufacturing 101: Part I*, WOHLERSASSOCIATES.COM.

[13] *Id.*

[14] *Id.*

[15] *Id.*

[16] *Id.*

[17] Ashlee Vance, *3-D Printing Spurs a Manufacturing Revolution*, N.Y. TIMES, Sept. 14, 2010, at A1, *available at* www.nytimes.com/2010/09/14/technology/14print.html?_r=2&ref=printers.

[18] The support material is removed after the part is completely constructed and the primary material has hardened. Wohlers, *Additive Manufacturing 101: Part I*, WOHLERSASSOCIATES.COM.

[19] Injection molding is a process whereby hot liquid plastic is injected into metal mold. After cooling, the two halves of the mold are separated and the part is removed.

[20] Mark P. Mills, *Manufacturing, 3D Printing and What China Knows About the Emerging American Century*, FORBES.COM (Jul. 5, 2011, 12:53 PM), www.forbes.com/sites/markpmills/2011/07/05/manufacturing-3d-printing-and-what-china-knows-about-the-emerging-american-century/.

[21] Vance, *3-D Printing Spurts a Manufacturing Revolution*, N.Y. TIMES, Sept. 14, 2010, at A1.

[22] Paul Wallich, *3-D Printing Takes Shape*, IEEE SPECTRUM (Jan. 2012), http://spectrum.ieee.org/robotics/diy/3d-printing-takes-shape ("Machining or sculpting the complex curves required for these [car] panels is far too time consuming and expensive to do any other way.").

the manufacturing process by building pre-assembled systems: a clock with all of its gears in place.[23]

Three-dimensional printers already build a multitude of products[24] out of a wide variety of plastics[25] and metals.[26] The technology is versatile, constructing furniture,[27] edible chocolate sculptures,[28] aerospace parts,[29] and even Stradivarius violins.[30] The adoption of the technology by the medical field evidences its quality and utility. In combination with 3D scanners, 3D printers are catalyzing innovations in body-contacting devices such as hearing aids,[31] prosthetics[32] and hip-replacement orthopedic implants.[33] Six thousand dental fillings and

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[23] Duncan Graham-Rowe, *3-D Printing for the Masses*, TECH. REV. (July 31, 2008), *available at* www.technologyreview.com/Infotech/21152/?nlid=1244&a=f.

[24] *See, e.g.*, Terry Wohlers, *Will Additive Manufacturing Change Manufacturing?*, WOHLERSASSOCIATES.COM (May-June 2011), www.wohlersassociates.com/MayJun11TC.htm.

[25] Terry Wohlers, *Additive Manufacturing 101: Part I*, WOHLERSASSOCIATES.COM, www.wohlersassociates.com/JanFeb10TC.htm ("FDM materials available are ABS, polycarbonate, PC/ABS, polyphenylsulfone, and ULTEM 9085."). Objet Geometries, an Israeli company, has developed a system that can mix two types of materials to yield a composite with various properties depending on the composition of the mixture. "For example, . . . a rigid white cell phone housing and rubbery black buttons within the same build." Z-Corp's plaster binding method can produce color objects. "Color is especially important when printing video game avatars, 3D maps from satellite imagery, detailed architectural structures, and industrial parts that require color to convey important information." Terry Wohlers, *Additive Manufacturing 101: Part III*, WOHLERSASSOCIATES.COM (May-June 2010), www.wohlersassociates.com/MayJun10TC.htm.

[26] Wohlers, *Additive Manufacturing 101: Part IV*, WOHLERSASSOCIATES.COM, www.wohlersassociates.com/JulAug10TC.htm ("A wide range of materials are available for use with the powder-bed systems. Among them are tool steel, stainless steel, cobalt-chrome alloys, pure titanium and titanium alloys, aluminum, nickel-based super alloys . . . and even gold.").

[27] FREEDOM OF CREATION, www.freedomofcreation.com/about (last visited Apr. 1, 2012).

[28] CANDYFAB.ORG, http://wiki.candyfab.org/ (last visited Apr. 1, 2012) ("The CandyFab Project aims to . . . promote the use of [AM] fabrication technologies for culinary, educational, and artistic purposes.").

[29] Wohlers, *Additive Manufacturing 101: Part IV*, WOHLERSASSOCIATES.COM.

[30] *Print me a Stradivarius*, ECONOMIST, Feb. 10, 2011, at 11, *available at* www.economist.com/node/18114327; *The Printed World*, ECONOMIST, Feb. 10, 2011, at 78, *available at* www.economist.com/node/18114221.

[31] Joseph Flaherty, *10 Things 3D Printers Can Do Now!*, REPLICATOR (Nov. 1, 2008), http://replicatorinc.com/blog/2008/11/10-things-3d-printers-can-do-now/ (explaining that 3D scanners and printers can design hearing aids that work more effectively due to their custom fit).

[32] Rachael King, *Printing in 3D Gets Practical: Military Surgeons, Architects and Others Are Creating Models with 3D Prints, and Prices Are Falling: Sub-$10,000 Printers on the Way*, BLOOMBERG BUSINESSWEEK SPECIAL REPORT (Oct. 6, 2008, 12:01 AM), www.businessweek.com/technology/content/oct2008/tc2008103_077223.htm (discussing use of 3D printers to build facial prosthetics and masks that aid in reconstructive surgery); Ashlee Vance, *3-D Printing Spurts a Manufacturing Revolution*, N.Y. TIMES, Sept. 14, 2010, at A1, *available at* www.nytimes.com/2010/09/14/technology/14print.html?_r=2&ref=printers (describing San Francisco-based company Bespoke making prosthetics at one tenth the cost of traditional methods).

[33] Wohlers, *Additive Manufacturing 101: Part IV*, WOHLERSASSOCIATES.COM.

bridges are printed daily.[34] Using 3D models obtained with CT scans, surgeons can even print a copy of a patient's own body out of tissue-mimicking plastic, allowing them to practice precarious operations before putting scalpel to skin.[35]

Compared to subtractive systems, 3D printers are easy to use.[36] They utilize increasingly user-friendly design software: Google now offers a free high-end program that can model anything from a coffee mug to a skyscraper.[37] For non-designers, free 3D models can be downloaded from the open-source design website Thingiverse.[38]

Three-dimensional printers are becoming widely accessible. While 3D printing systems for metal are still expensive, costing between $150,000 and $1 million,[39] some printers making plastic parts have dropped below $1000.[40] People can build their own 3D printers with the help of several open-source online communities.[41] Those wishing to avoid purchasing equipment can have their designs built for between $50 and $150 through the online company Shapeways.[42] Similarly, Royal

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[34] *Id.*

[35] King, *Printing in 3D Gets Practical: Military Surgeons, Architects and Others Are Creating Models with 3D Prints, and Prices Are Falling: Sub-$10,000 Printers on the Way*, BLOOMBERG BUSINESSWEEK SPECIAL REPORT.

[36] For example, proficiency with Computer Numeric Control milling machines requires extensive training, both in order to build useful parts and prevent the user from damaging the expensive equipment.

[37] *See* SketchUp (computer software), *available at* http://sketchup.google.com/ (last visited Apr. 1, 2012).

[38] THINGIVERSE, www.thingiverse.com/about (last visited Apr. 1, 2012) ("Thingiverse is a place for you to share your digital designs with the world. We believe that just as computing shifted away from the mainframe into the personal computer that you use today, digital fabrication will share the same path. . . . We're hoping that together we can create a community of people who create and share designs freely, so that all can benefit from them.").

[39] Wohlers, *Additive Manufacturing 101: Part IV*, WOHLERSASSOCIATES.COM.

[40] PRINTRBOT.COM, http://printrbot.com/ (last visited Apr. 1, 2012) (listing Printrbot LC at $549).

[41] For example, RepRap is an open-source project aspiring to create a free 3D printer that can reproduce itself, allowing consumers to print both useful household items well as more 3D printers for friends. While the current version of RepRap can build only in plastic, the team is striving for the next version to be capable of printing multiple materials leading to the production of circuit boards. REPRAP.ORG, http://reprap.org/wiki/Main_Page (last visited Apr. 1, 2012); *see also* FAB@HOME, http://fabathome.org (last visited Apr. 1, 2012) (open source project by Cornell University); MAKERBOT INDUSTRIES, www.makerbot.com (last visited Apr. 1, 2012) ("Maker Bot is an affordable, open source 3D printer. It makes almost everything [plastic] up to 4"x4"x6".").

[42] *See* Duncan Graham-Rowe, *3-D Printing for the Masses*, TECH. REV. (July 31, 2008), *available at* www.technologyreview.com/Infotech/21152/?nlid=1244&a=f ; SHAPEWAYS, www.shapeways.com (last visited Apr. 1, 2012); *see also* CONCEPTS RAPID PRODUCT DEVELOPMENT, www.solidconcepts.com (last visited Apr. 1, 2012); PONOKO, www.ponoko.com (last visited Apr. 1, 2012).

Philips Electronics allows an inventor to upload and price designs.[43] The company then prints copies of the piece and ships them directly to consumers.[44]

Additive manufacturing is poised to capsize economic paradigms.[45] AM has already greatly reduced design cost and production time,[46] allowing American companies to compete with China's low labor costs.[47] Design is no longer beholden to widespread appeal, because 3D printers allow companies to make any product on demand, without the high costs of re-equipping factories with specialized tools that a particular product normally requires.[48] In other words, economies of scale—the increased efficiencies of large-scale production—are breaking down.[49] Corporations are at risk of being undercut by imaginative and newly empowered individuals.[50] Eric von Hippel, professor at the Massachusetts Institute of Technology, describes the overall changes in manufacturing succinctly: "Hardware is becoming much more like software."[51]

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[43] Nathan Olivarez-Giles, *3-D Printers Go Way Beyond Paper and Ink*, L.A. TIMES, June 7, 2010, *available at* www.wenatcheeworld.com/news/2010/jun/07/3-d-printers-go-way-beyond-paper-and-ink-think/.

[44] *Id.*

[45] *See* Anderson, *In the Next Industrial Revolution, Atoms Are the New Bits*, WIRED, Jan. 25, 2010, *available at* www.wired.com/magazine/2010/01/ff_newrevolution (explaining that "micro companies" will overtake large corporations and dismantle traditional notions of manufacturing and distribution).

[46] *A Factory on Your Desk*, ECONOMIST TECH. Q., Sept. 3, 2009, *available at* www.economist.com/node/14299512 ("It used to take Timberland, an American firm, a week to turn the design of a new sole into a model, at a cost of around $1,200. Using a 3-D printer made by Z Corporation . . . it has cut the time to 90 minutes and the cost to $35.").

[47] Jeremy Quittner, *How 3D Printing Is Saving This Jewelry Design Business: The Printers Cost, but They Allow Tech-Designs to Face Down Competition from China*, CRAIN'S NEW YORK BUSINESS.COM (Oct. 20, 2010, 9:37 AM), www.crainsnewyork.com/article/20101020/SMALLBIZ/101029996.

[48] The founder of Amsterdam-based Freedom of Creation says his company can risk "out there" designs because of 3D printer technology. Ashlee Vance, *3-D Printing Spurs a Manufacturing Revolution*, N.Y. TIMES, Sept. 14, 2010, at A1, *available at* www.nytimes.com/2010/09/14/technology/14print.html?_r=2&ref=printers.

[49] Anderson, *In the Next Industrial Revolution, Atoms Are the New Bits*, WIRED, Jan. 25, 2010.

[50] *See id.* ("Transformative change happens when industries democratize, when they're ripped from the sole domain of companies, governments, and other institutions and handed over to regular folks. . . . [It is now] happening to manufacturing . . . . The collective potential of a million garage tinkerers is about to be unleashed on the global markets, as ideas go straight into production, no financing or tooling required.").

[51] *Id.*

The technology is headed for shocking advances. One company, for example, is printing an airplane wing as a single piece of titanium.[52] Contour, a California start-up, has designed a giant 3D printer that fits on a tractor-trailer to "squirt out layers of special concrete and build entire walls that could be connected to form the basis of a house."[53] A few specialized printers are already capable of using living cell tissue as a building material, a technique that may one day produce complete human body parts.[54] Adrian Bowyer, director of the open source RepRap project at Bath University, believes that 3D printers, like mechanical flowers, will aspire to self-replication—with people acting as their symbiotic insect-pollinators.[55] Manufacture of guns, it seems, is inevitable.

B. FIREARM COMPONENTS REPLICABLE BY 3D PRINTERS

> "The United States Special Operations Command (SOCOM) announced on Monday that they'd like to buy a 3D printer. . . . The command's announcement doesn't say [why]."[56]

On September 20, 2011, Thing #11669 was uploaded to Thingiverse.com, the premier database for free user-generated 3D printer files.[57] There immediately ensued a controversy within the site's online community over whether this Thing, a digital blueprint for an AR-15 assault rifle component, should be available for download.[58] After an

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[52] *The Printed World*, ECONOMIST, Feb. 12, 2011, at 77, *available at* www.economist.com/node/18114221.

[53] Vance, *3-D Printing Spurs a Manufacturing Revolution*, N.Y. TIMES, Sept. 14, 2010, at A1.

[54] *A Factory on Your Desk*, ECONOMIST TECH. Q., Sept. 3, 2009, *available at* www.economist.com/node/14299512.

[55] Adrian Bowyer, *RepRap*, VIMEO (Jan. 26, 2012), http://vimeo.com/5202148 ("[T]he plants need to pollinate each other but they can't move, so they make nectar as well as pollen. The insects visit the plant to obtain the nectar, and in doing so transfer the pollen to other plants. . . . The RepRap printer is intended to be exactly the same, with people taking the role of insects and the printer taking the role of the flowers—because the RepRap printer doesn't just copy itself, it also makes useful goods, and those goods are the equivalent of the nectar, and that nectar . . . rewards the people who assemble the machine . . . .").

[56] Adam Rawnsley, *MakerBot Commandos: Special Ops Seek 3D Printer*, WIRED, Aug. 12, 2011, *available at* www.wired.com/dangerroom/2011/08/special-ops-meets-makerbot-commandos-want-3d-printer/.

[57] KingLudd, *AR-15 Lower Receiver*, THINGIVERSE (Sept. 19, 2011), www.thingiverse.com/thing:11669 (digital CAD file).

[58] Bre Pettis, *Deadly Weapons on Thingiverse*, THINGIVERSE BLOG (Oct. 3, 2011), http://blog.thingiverse.com/2011/10/03/deadly-weapons-on-thingiverse/.

impassioned debate the part remains posted.[59] But this discourse will be the first of many. As the capability of consumer-available 3D printers proliferates, an increasing number of gun components, which vary in material demand according to their role and function within the firearm, will become replicable by the technology.

The seemingly intricate semi-automatic firearm, the long shadow of centuries of monolithic advances in science and engineering, is an entirely mechanical device that, once disassembled, is but a collection of relatively simple pieces. Because metal 3D printers already produce aerospace-grade parts,[60] it seems likely that many if not all of these pieces will soon be produced by additive manufacturing. For all their capability, however, metal 3D printers are prohibitively expensive for widespread public access. Plastic printers, on the other hand, may soon be prevalent.

Plastics, also known as "polymers," are widely employed by the firearm industry. They are ubiquitously used for cosmetic features such as grips and handles, for magazines that hold ammunition, and even for small, traditionally metal parts like triggers.[61] One of the most important pieces of a firearm is the "frame" or "receiver" (hereinafter "frame"), the central piece that holds all of the other components together to form a working unit. Many guns, including over sixty percent of handguns used by the police, now employ plastic frames.[62]

Despite frequent use of plastics by the gun industry, employing them in some components would compromise a firearm's safety and durability. Barrels have thus far been made exclusively of metal to withstand the acute pressure of explosive powder and the heat generated by the friction of traversing bullets.[63] They must also be made such that

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[59] *Id.*

[60] Terry Wohlers, *Will Additive Manufacturing Change Manufacturing?*, WOHLERSASSOCIATES.COM (May-June 2011), www.wohlersassociates.com/MayJun11TC.htm.

[61] *See, e.g.*, Charles H. Chandler, *Gun-Making as a Cottage Industry*, 3 J. ON FIREARMS & PUB. POL'Y 155, 158-59 (1990) ("Many parts of a weapon, however, may appropriately be made of non-metallic materials, including various polymers; and a modern 9mm semi-automatic pistol, the notorious Glock 17, makes extensive use of high performance plastics. . . . Plastic magazines for some semiautomatic pistols are already on the market.").

[62] Paul Scarlata, *Shootout! Polymer Police Pistols*, GUNS AND AMMO.COM (Sept. 24, 2010), www.handgunsmag.com/2010/09/24/featured_handguns_polysh_032707/ ("Despite . . . dire predictions and downright hatred directed toward them, polymer-frame pistols quickly became the hottest items on the police handgun market. . . . And for good reason. Modern polymers provide equal, if not superior, resistance to wear, abrasion, solvents, oils and environmental extremes as steel and alloy-frame pistols.").

[63] *See* Geoffrey Kolbe, *The Making of a Rifled Barrel*, FIREARMID.COM (July 2000), http://firearmsid.com/Feature%20Articles/RifledBarrelManuf/BarrelManufacture.htm ("The barrel of any firearm is [subject to pressures of] 50,000 pounds per square inch or more, and special steels are required to safely withstand these stresses.").

the fit between the barrel's bore and the bullet is precise, often to thousands of an inch.[64] Barrels also include legally significant and traditionally difficult-to-manufacture "rifling," helical grooves cut into the interior of the barrel that increase a bullet's range and accuracy by causing the bullet to spin as it travels.[65] Probably only high-end metal 3D printers possess the capability to build rifled barrels within the boundaries of this required precision (in the parlance of machining, the "tolerance"). It might therefore be some time before printers available to consumers can produce complete, high-quality firearms of the variety currently available from the gun industry.

Nevertheless, the current inability of 3D printers to produce every component of industrially available firearms is insignificant for the legal implications of the technology. Rather than remain in a vacuum, firearm design will change to accommodate the capabilities of inexpensive 3D printers. Of more present importance, the firearm regulatory system has rested its faith in controlling only one of the many components of a firearm, its frame. Thing #11669, the first consumer-printable part to be posted online, happens to be this linchpin component.

II. THE LAW AND THE GUN INDUSTRY

A. HOW GUNS ARE SUPPOSED TO FLOW IN THE MARKETPLACE: REGULATION OF MANUFACTURE, DISTRIBUTION AND OWNERSHIP

A "limited system"[66] that's "pervasively regulated."[67]

Congress has erected a complex scheme to regulate the production, distribution and possession of firearms. Anyone "engage[d] in the business"[68] of manufacturing, importing or dealing in firearms is

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[64] For example, many bullets, which are measured in decimal inches (caliber), are sized to thousands of an inch, such as .308 caliber rifle rounds. *See* Jon R. Sundra, *All About Barrels*, PETERSEN'S RIFLESHOOTER (Sept. 23, 2010), www.rifleshootermag.com/2010/09/23/gunsmithing_rsgunsmith1/ (discussing barrel tolerance on the order of a few thousandths of an inch).

[65] *Rifling*, WIKIPEDIA (Mar. 24, 2012, 2:18 AM), http://en.wikipedia.org/wiki/Rifling.

[66] Tamar Gabelnick et al., A GUIDE TO THE US SMALL ARMS MARKET, INDUSTRY AND EXPORTS, 1998–2004 (2006), *available at* www.smallarmssurvey.org/fileadmin/docs/B-Occasional-papers/SAS-OP19-US.pdf (Small Arms Survey, an international arms monitoring organization, describing the United States gun control system).

[67] United States v. Biswell, 406 U.S. 311, 316 (1972) (referring to the firearms industry).

[68] A person manufacturing firearms is "engaged in the business" if he or she "devotes time, attention, and labor to manufacturing firearms as a regular course of trade or business with the principal objective of livelihood and profit through the sale or distribution of the firearms

required to become a federal firearm licensee ("FFL").[69] At its creation, a gun must possess a serial number[70] that the manufacturer is required to keep on record.[71] Once built, firearms are sold by the FFL manufacturer to FFL dealers such as pawnshops and retail stores. Federal law requires dealers to keep records on almost all firearm transactions,[72] and any transfers in interstate commerce must occur between licensees.[73] No one, not even an FFL, may transfer a firearm to a person who is known or reasonably believed to be an out-of-state resident,[74] felon or fugitive from the law.[75] A private individual first comes into contact with the system when he or she attempts to purchase a new firearm from an FFL dealer. The prospective buyer submits to the National Instant Criminal Background Check System ("NICS");[76] if the buyer is of age,[77] and not otherwise prohibited from possessing a firearm, the transfer is approved and the NICS records of the applicant's identity are destroyed.[78] While the FFL dealer retains paper purchase records, those records may not be digitized or compiled into a database by the Bureau of Alcohol, Tobacco, Firearms and Explosives ("ATF"), the agency that promulgates and enforces firearm regulation consistent with federal statute.[79]

When a gun is separated into components, the only piece considered a "firearm" for regulatory purposes is the central "frame or receiver."[80]

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manufactured." 18 U.S.C.A. § 921(a)(21)(A) (Westlaw 2012). The definition is similar for dealers and importers. "Principal objective of livelihood and profit" means "the intent underlying the sale or disposition of firearms is predominantly one of obtaining livelihood and pecuniary gain." 18 U.S.C.A. § 921(a)(22) (Westlaw 2012).

[69] 18 U.S.C.A. § 922 (a)(1)(A) (Westlaw 2012). Applicants are required to submit fingerprints and photographs. 18 U.S.C.A. § 923(a) (Westlaw 2012).

[70] 27 C.F.R. § 479.102 (Westlaw 2012).

[71] 27 C.F.R. § 478.123 (Westlaw 2012).

[72] 27 C.F.R. §§ 478.124, 478.125(e) (Westlaw 2012). Firearms entering or leaving the dealer's "personal collection" are exempted from recording requirements. 27 C.F.R. § 478.11 (Westlaw 2012).

[73] 18 U.S.C.A. § 922(a)(2) (Westlaw 2012).

[74] 18 U.S.C.A. § 922(b)(3) (Westlaw 2012).

[75] 18 U.S.C.A. § 922(d)(1) (Westlaw 2012).

[76] 18 U.S.C.A. § 922(t)(1) (Westlaw 2012).

[77] One must be at least eighteen years of age to acquire long-rifles and twenty-one to acquire handguns. 18 U.S.C.A. § 922(b)(1) (Westlaw 2012).

[78] 18 U.S.C.A. § 922(t)(2)(c) (Westlaw 2012).

[79] *How Thousands of U.S. Guns Fuel Crime in Mexico*, FRESH AIR (Jan. 5, 2011), *available at* www.npr.org/2011/01/05/132652351/tracking-gun-dealers-linked-to-mexican-violence.

[80] 18 U.S.C.A. § 921(a)(3) (Westlaw 2012). The ATF defines "frame or receiver" as "[t]hat part of a firearm which provides housing for the hammer, bolt or breechblock, and firing mechanism, and which is usually threaded at its forward portion to receive the barrel." 27 C.F.R. § 478.11 (Westlaw 2012). The frame is also considered the primary component for marking and regulation in Europe. ORG. FOR SEC. & COOPERATION IN EUROPE, HANDBOOK OF BEST PRACTICES ON SMALL ARMS AND LIGHT WEAPONS ORGANIZATION FOR SECURITY AND CO-OPERATION IN EUROPE 1, 9 (2003), *available at* www.osce.org/fsc/13616 ("Major components for the manufacture of [guns]

Variation in design abounding,[81] the ATF designates which component qualifies.[82] All other domestically produced components for common firearms are unregulated.[83] Thus, control of the frame, an essential component unobtainable from an FFL without a background check, theoretically prevents assembly of guns from over-the-counter parts.

While parts for common guns are unrestricted, heightened restrictions apply to fully assembled guns with certain component arrangements and also to individual parts that enable rapid fire. Primarily, these restrictions arise under The National Firearm Act ("NFA"), passed in 1934 to illegalize weapons favored by organized crime.[84] Today, the list of "NFA firearms" includes machineguns, short-barreled rifles, "smoothbore" handguns that lack rifling, and highly concealable Cold War curiosities such as pen and umbrella guns.[85] In addition, machinegun frames, along with any components designed to convert a weapon to automatic fire, are both defined as NFA firearms.[86] Manufacturers, dealers, and possessors of these NFA firearms must be specially registered.[87] Apart from NFA restrictions, there are a few overarching design requirements for all firearms. For example, the Undetectable Firearm Act of 1988 requires that all major gun components generate accurate depictions in x-ray machines and also requires assembled firearms to trigger metal detectors.[88] In contrast to regulating functional attributes, mostly aesthetic features such as grips

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(i.e., firearms frames and receivers) should be controlled and appropriately marked upon manufacture.").

[81] S*ee* STEPHEN P. HALBROOK, FIREARMS LAW DESKBOOK § 2:4 (Westlaw 2012) (discussing ATF designation of regulated components).

[82] *Id.*

[83] There are, however, import restrictions on many parts. Certain firearm models are prohibited from including more than ten imported "essential components." 27 C.F.R. § 478.39 (Westlaw 2012). Importation of gun barrels and "ammunition feeding devices" are also restricted. 27 C.F.R. §§ 478.112–.115, 478.119 (Westlaw 2012).

[84] Brian L. Frye, *The Peculiar Story of* United States v. Miller, 3 N.Y.U. J. L. & LIBERTY 48, 60-62 (2008).

[85] 26 U.S.C.A. § 5845 (Westlaw 2012). For illustrations of pen and umbrella guns, see BUREAU OF ALCOHOL, TOBACCO, FIREARMS & EXPLOSIVES, NATIONAL FIREARMS ACT HANDBOOK 1, 5-10 (rev. 2009), *available at* www.atf.gov/publications/firearms/nfa-handbook/.

[86] For example, a modified AR-15 frame becomes an M16 frame capable of facilitating automatic fire, transforming it into an "NFA firearm." HALBROOK, FIREARMS LAW DESKBOOK § 2:4. But the definition of "machine gun" is more expansive than an assembled firearm or its frame: it also includes any component "intended solely and exclusively, or combination of parts designed and intended, for use in converting a weapon into a [gun capable of automatic fire]." 26 U.S.C.A. § 5845(b) (Westlaw 2012). These conversion components are therefore an exception to the general rule that non-frame parts are unregulated.

[87] 26 U.S.C.A. §§ 5841–5843 (Westlaw 2012).

[88] 18 U.S.C.A. § 922(p) (Westlaw 2012).

and handles were controversially regulated by the now-expired "Assault Weapons" ban.[89]

Somewhat surprisingly, especially in light of the pervasive federal regulation of consumer goods, firearm safety with respect to the user is maintained by the industry voluntarily. Firearms and ammunition are explicitly outside the authority of the Consumer Product Safety Commission.[90] Rather, in 1926, at the request of Congress, the Sporting Arms and Ammunition Manufacturers' Institute was established,[91] a private organization that, by publishing voluntarily adopted industry standards, has largely eliminated the risk of mechanical failures that endanger users and bystanders.[92]

Individuals who produce guns for personal use fall outside the major regulatory system; they are not required to be licensed, as they are not "engaging in the business" of manufacture.[93] As long as a person is not otherwise prohibited from possessing a firearm and conforms to applicable state laws, he or she may legally make a non-NFA firearm.[94]

B. HOW GUNS ACTUALLY FLOW: THE INDUSTRY'S TRIBUTARIES, OUTLETS AND LEAKS

The effect 3D printers will have on industry distribution and acquisition must be assessed not just according to legal theory, but also with regard to how firearms actually circulate in the economy. Indeed, the stream of commerce does not flow as ideally as regulators would hope.

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[89] 18 U.S.C. § 922(v) (2000) (expired by sunset clause 2004).

[90] Consumer Product Safety Commission Improvements Act of 1976, Pub. L. No. 94-284, § 3(e), 90 Stat. 503, 504 ("The Consumer Product Safety Commission shall make no ruling or order that restricts the manufacture or sale of firearms, firearms ammunition, or components of firearms ammunition, including black powder or gunpowder for firearms."); Dennis B. Wilson, *What You Can't Have Won't Hurt You! The Real Safety Objective of the Firearms Safety and Consumer Protection Act*, 53 CLEV. ST. L. REV. 225 (2005-2006) (explaining the restrictions on the CPSC as allaying concerns the commission might use its authority as a "back-door" firearms regulation method).

[91] Wilson, *What you Can't Have Won't Hurt You! The Real Safety Objective of the Firearms Safety and Consumer Protection Act*, 53 CLEV. ST. L. REV. at 228.

[92] *Id.* at 228-29 ("This system . . . has largely eliminated the problem of firearms experiencing mechanical failures so severe that they risk endangering the shooter or bystanders.").

[93] 18 U.S.C.A. § 921(a)(21)(A) (Westlaw 2012).

[94] BUREAU OF ALCOHOL, TOBACCO, FIREARMS & EXPLOSIVES, *Firearms Technology*, www.atf.gov/firearms/faq/firearms-technology.html (last visited Apr. 1, 2012) ("For your information, per provisions of the Gun Control Act (GCA) of 1968, 18 U.S.C. Chapter 44, an unlicensed individual may make a 'firearm' as defined in the GCA for his own personal use, **but not for sale or distribution**.") (emphasis in original). However, anyone building a firearm must still use the requisite number of domestic parts. 27 C.F.R. § 478.39 (Westlaw 2012).

Consumers acquire firearms from one of two main sources: the "primary market" or the "secondary market."[95] Four and a half million new guns are purchased each year in the United States, creating an enormous market that accounts for over half of the world's annual production.[96] This is the primary market: never-before-cycled firearms crafted by FFL manufacturers and sold by FFL dealers.[97] In addition, the "secondary market"—private trades by individuals—accounts for thirty to forty percent of total annual gun sales.[98] These horizontal transfers do not invoke the NICS background-check system,[99] and after guns undergo several secondary market transfers they become almost impossible to trace from their origin.[100] The potential size of the secondary market is vast. The United States has an inventory of almost 300 million firearms in civilian circulation, accounting for thirty-five to fifty percent of the world's civilian-held stockpile.[101]

New firearms from the primary market or used guns from America's private reserves reach criminals through several channels, although the significance of each seemingly large hole in the system is disputed.[102] Many guns are stolen,[103] with some ending up on the black

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[95] Philip J. Cook et al., *Regulating Gun Markets*, 86 J. CRIM. L. & CRIMINOLOGY 59, 68-70 (1995).

[96] SMALL ARMS SURVEY, SMALL ARMS SURVEY 2007: GUNS AND THE CITY 46 (2007), *available at* www.smallarmssurvey.org/publications/by-type/yearbook/small-arms-survey-2007.html.

[97] Cook et al., *Regulating Gun Markets*, 86 J. CRIM. L. & CRIMINOLOGY at 68.

[98] Nicholas J. Johnson, *Imagining Gun Control in America: Understanding the Remainder Problem*, 43 WAKE FOREST L. REV. 837, 870 (2008).

[99] Adam Winkler, Heller*'s Catch-22*, 56 UCLA L. REV. 1551, 1556-58 (2009). These legal lateral transfers have been termed the "gun show loophole," as secondary market transactions often occur at these events. Andrew J. McClurg, *Sound-Bite Gun Fights: Three Decades of Presidential Debating About Firearms*, 73 U. MO. KAN. CITY L. REV. 1015, 1034 n.71 (2005). Private individuals are still prohibited from transferring firearms to people they reasonably believe to be out-of-state residents, felons, fugitives, drug users or mentally insane. 18 U.S.C.A. §§ 922(a)(5), (d) (Westlaw 2012).

[100] Philip J. Cook et al., *Underground Gun Markets* 31 (Nat'l Bureau of Econ. Research, Working Paper No. 11737, 2005), *available at* www.nber.org/papers/w11737 ("even when guns are successfully traced this process can only identify the first purchaser from a FFL, and provides no information on subsequent transactions in the underground distribution chain."). For a discussion of how guns are traced, see Gary Kleck & Shun-Yung Kevin Wang, *The Myth of Big-Time Gun Trafficking and the Overinterpretation of Gun Tracing Data*, 56 UCLA L. REV. 1233, 1253-54 (2009).

[101] In 2007, the United States was estimated to have between 250 million and 290 million guns, amounting to 35-50% of the world's civilian-held total. The Small Arms Survey also notes that "[t]hese figures do not include . . . craft-produced civilian guns." SMALL ARMS SURVEY, SMALL ARMS SURVEY 2007: GUNS AND THE CITY 39-47 (2007), *available at* www.smallarmssurvey.org/publications/by-type/yearbook/small-arms-survey-2007.html.

[102] For example, one dispute centers on whether guns reach criminals through a few high-volume "point sources" (dealers illegally or negligently selling firearms) or many low-volume "dispersed sources" (private individuals selling legally). *Compare* Anthony A. Braga et al., *The*

market.[104] Criminals sometimes get away with primary market purchases, aided by corrupt or negligent FFL dealers.[105] Similarly, "straw purchasers" with clean criminal records purchase guns from the primary market and then peddle them to the underworld.[106] Interstate traffickers may move new guns from locations of lenient laws to stricter states,[107] where they are re-sold on the black market.[108] Because states sometimes fail to report felonies to the federal government, the NICS system may miss other criminal purchasers.[109] Felons also buy guns from unsuspecting secondary market sellers at gun shows, flea markets,[110] and through classified ads in magazines and newspapers.[111]

Until now, personal manufacture of firearms seems absent from the long-running debate over illegitimate gun acquisition.[112] A number of

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Illegal Supply of Firearms, 29 CRIME & JUST. 319, 337-39 (2002) (contending point sources are significant), *with* Adam Winkler, Heller*'s Catch-22*, 56 UCLA L. REV. 1551 (2009) (contending dispersed sources are significant).

[103] In 2007, 137,930 firearms were reported stolen. U.S. DEP'T OF JUSTICE, BUREAU OF JUSTICE STATISTICS, CRIMINAL VICTIMIZATION IN UNITED STATES, 2007 STATISTICAL TABLES, tbl.84 (2010), *available at* http://bjs.ojp.usdoj.gov/content/pub/pdf/cvus07.pdf. For a comprehensive discussion of gun theft, see Kleck & Wang, *The Myth of Big-Time Gun Trafficking and the Overinterpretation of Gun Tracing Data*, 56 UCLA L. REV. at 1242-43.

[104] Kleck & Wang, *The Myth of Big-Time Gun Trafficking and the Overinterpretation of Gun Tracing Data*, 56 UCLA L. REV. at 1248-52.

[105] For a list of sources arguing that many guns used in crime are trafficked from primary markets to illicit markets, *see id.* at 1236 n.10.

[106] *See* Allen Rostron, *Shooting Stories: The Creation of Narrative and Melodrama in Real and Fictional Litigation Against the Gun Industry*, 73 U. MO. KAN. CITY L. REV. 1047, 1053 (2005) (describing case in which licensed gun dealer sold over fifty handguns to a janitor who resold them in classified newspaper ads). *But see* Kleck & Wang, *The Myth of Big-Time Gun Trafficking and the Overinterpretation of Gun Tracing Data*, 56 UCLA L. REV. at 1253 (indicating this practice may be rare).

[107] *But see* Kleck & Wang, *The Myth of Big-Time Gun Trafficking and the Overinterpretation of Gun Tracing Data*, 56 UCLA L. REV. at 1263 (disputing the significance of such movement).

[108] *Id.* at 1248-52 (explaining that the prices of black market firearms are lower than those of new firearms, indicating they are stolen rather than purchased).

[109] Adam Winkler, Heller*'s Catch-22*, 56 UCLA L. REV. 1551, 1556 (2009).

[110] Anthony A. Braga & David M. Kennedy, *Gunshows and the Illegal Diversion of Firearms*, 6 GEO. PUB. POL'Y REV. 7 (2000) (concluding gun shows and flea markets represent a major source of firearms obtained by criminals). *But see* Kleck & Wang, *The Myth of Big-Time Gun Trafficking and the Overinterpretation of Gun Tracing Data*, 56 UCLA L. REV. at 1248 (suggesting the percentage of guns obtained by criminals at these events may be low).

[111] Philip J. Cook et al., *Regulating Gun Markets*, 86 J. CRIM. L. & CRIMINOLOGY 59, 68-69 (1995).

[112] *Cf.* Anthony A. Braga et al., *The Illegal Supply of Firearms*, 29 CRIME & JUST. 319 (2002) (making no mention of personally manufactured firearms as a source to criminals). But there have been convictions for possession of homemade firearms. In 2003, Robert W. Stewart was convicted for possession of five homemade machineguns. United States v. Stewart, 451 F.3d 1071, 1072-73 (9th Cir. 2006). In upholding the federal NFA ability to regulate machineguns under the Commerce Clause, the Ninth Circuit noted that "[h]omemade guns, even those with a unique design, can enter the interstate market and affect supply and demand." *Id.* at 1078.

responsible firearm hobbyists make their own gun components, especially frames, which are easier to produce than other parts such as barrels.[113] Some criminals certainly do build their own guns,[114] but they are generally crude, improvised weapons that are often just as dangerous to the shooter as the target.[115]

However, one of several civil suits brought against firearm manufactures in the 1990's provides a rare example of a criminal building an industrially designed firearm from a frame.[116] In *Halberstam v. S.W. Daniel, Inc.*, the defendant parts supplier sold through mail order a self-assembly kit with an unfinished frame.[117] Because the company was technically not selling firearms,[118] it took orders over the phone and kept no sales records.[119] One of these kits was purchased, completed at home, and used in a fatal shooting.[120] The supplier was not held liable, as the jury decided the defendant's negligent marketing had not caused the victim's death.[121] Other lawsuits alleging negligent distribution plagued the firearm industry until 2005,[122] when, following the lead of

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[113] *E.g.*, CNC GUNSMITHING, www.cncguns.com/downloads.html. (last visited Apr. 1, 2012) (offering tools to aid in building firearm frames).

[114] T. Markus Funk, Comment, *Gun Control and Economic Discrimination: The Melting-Point Case-in-Point*, 85 J. CRIM. L. & CRIMINOLOGY 764, 774 (1995) (explaining that twenty percent of guns confiscated from criminals in Washington D.C. in 1986 were homemade).

[115] *Improvised Firearm*, WIKIPEDIA (Apr. 1, 2012, 5:55 PM), http://en.wikipedia.org/wiki/Improvised_firearm#cite_note-purgatory-0.

[116] Halberstam v. S.W. Daniel, Inc., No. 95 Civ. 3323, slip op. (E.D.N.Y. Apr. 1, 1998). For a detailed account of this unreported case, see Timothy D. Lytton, Halberstam v. Daniel *and the Uncertain Future of Negligent Marketing Claims Against Firearms Manufacturers*, 64 BROOK. L. REV. 681 (1998). A television courtroom drama, *The Practice*, based a 1999 episode on the facts of the case. Allen Rostron, *Shooting Stories: the Creation of Narrative and Melodrama in Real and Fictional Litigation Against the Gun Industry*, 73 UMKC L. REV. 1047, 1056 (2005).

[117] Lytton, Halberstam v. Daniel *and the Uncertain Future of Negligent Marketing Claims Against Firearms Manufacturers*, 64 BROOK. L. REV. at 688, 695-96.

[118] *See supra* note 80.

[119] Lytton, Halberstam v. Daniel *and the Uncertain Future of Negligent Marketing Claims Against Firearms Manufacturers*, 64 BROOK. L. REV. at 695.

[120] The facts are quite tragic: the company had advertised its Cobray M-11/9 model firearm as the "Drug Lord['s] choice," and the victim was a sixteen-year-old boy. *Id.* at 686, 695-96.

[121] *Id.* at 697-98.

[122] The lawsuits had a significant effect on the industry, their associated legal costs driving several small manufacturers bankrupt and influencing some companies to drastically reduce domestic arms sales. Tamar Gabelnick et al., A GUIDE TO THE US SMALL ARMS MARKET, INDUSTRY AND EXPORTS 44-45, 1998–2004 (2006) *available at* www.smallarmssurvey.org/nc/de/publications/by-type/occasional-papers. This litigation, encouraged by activists frustrated with legislative inaction, generally died at summary judgment. For a summery of lawsuits against the gun industry, see Allen Rostron, *Shooting Stories: the Creation of Narrative and Melodrama in Real and Fictional Litigation Against the Gun Industry*, 73 UMKC L. REV. 1047, 1049-56 (2005).

33 states,[123] the federal government immunized the industry with the Protection of Lawful Commerce in Arms Act.[124] This legislation effectively ended the "gun tort" era.[125]

III. HOW 3D PRINTERS OBSOLETE THE REGULATORY SYSTEM

> "[H]olding back the manufacture of plastic firearms in the United States would be about the equivalent of sweeping back Lake Erie with a broom."[126]

A. FRAMES ARE AN OBSOLETE BASIS FOR DEFINING FIREARMS

The firearm regulatory system is rooted in the idea that guns can be controlled at their source through a system of licensing, record keeping, and pre-distribution background checks. With few exceptions this system follows only one component—the frame. This is the only part a licensed manufacturer must stamp with a serial number,[127] a number the ATF depends upon to trace recovered guns to FFL dealers who improperly or illegally distribute firearms.[128] The sale of a frame or a complete gun that includes one is the threshold event requiring an FFL dealer to conduct a background check.[129] Transfer of the frame to a

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[123] David B. Kopel, *The Right to Arms in the Living Constitution*, 2010 CARDOZO L. REV. DE NOVO 99, 124 n.104 (2010).

[124] Protection of Lawful Commerce in Arms Act, Pub. L. No. 109-92, 119 Stat. 2095 (2005); *see Congress Passes Prohibition of Qualified Civil Claims Against Gun Manufacturers and Distributors*, 119 HARV. L. REV. 1939, 1941 (2006) ("The operational text of the Act is brief yet effective. First, '[a] qualified civil liability action may not be brought in any Federal or State court.' Second, '[a] qualified civil liability action that is pending on the date of enactment of this Act shall be immediately dismissed by the court in which the action was brought or is currently pending.' A 'qualified civil liability action' is an action brought against a dealer, manufacturer, or trade association for damages resulting from the unlawful use of a firearm by another.'") (footnotes omitted).

[125] *See generally* Allen Rostron, Book Review, *Lawyers, Guns, & Money: The Rise and Fall of Tort Litigation Against the Firearms Industry*, 46 SANTA CLARA L. REV. 481 (2006) (reviewing SUING THE GUN INDUSTRY: A BATTLE AT THE CROSSROADS OF GUN CONTROL AND MASS TORTS Timothy D. Lytton ed., 2005).

[126] 134 CONG. REC. 3088-02 (daily ed. May 10, 1988) (statement of Rep. Edward F. Feighan).

[127] 27 C.F.R. § 479.102 (Westlaw 2012).

[128] *See How Thousands of U.S. Guns Fuel Crime in Mexico*, FRESH AIR (Jan. 5, 2011), *available at* www.npr.org/2011/01/05/132652351/tracking-gun-dealers-linked-to-mexican-violence.

[129] *See* 18 U.S.C.A. § 921(a)(3) (Westlaw 2012). The ATF defines "frame or receiver" as "[t]hat part of a firearm which provides housing for the hammer, bolt or breechblock, and firing mechanism, and which is usually threaded at its forward portion to receive the barrel." 27 C.F.R. § 478.11 (Westlaw 2012). The frame is also considered the primary component for marking and regulation in Europe. ORG. FOR SEC. & COOPERATION IN EUROPE, HANDBOOK OF BEST PRACTICES

prohibited person, by an FFL dealer or private individual, is the criminal act. The cornerstone of this system, then—the unspoken assumption—is that the frame is difficult for an ordinary person to make.[130]

In the last two decades, trends in firearm design and small-scale manufacturing have converged to vest ordinary hands with the power to produce frames.[131] On one side, the firearm industry has moved toward frames built of polymer materials.[132] On the other side, relatively inexpensive, consumer-friendly 3D printers have become an alternative to complex fabrication techniques.[133] Three-dimensional printers, increasingly available to the general public, can print objects much more intricate than firearm frames in impact-[134] and heat-resistant[135] materials. Some 3D digital files for firearm frames are already available online for free,[136] and 3D scanners could also be used to create printable models

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ON SMALL ARMS AND LIGHT WEAPONS ORGANIZATION FOR SECURITY AND CO-OPERATION IN EUROPE 1, 9 (2003), *available at* www.osce.org/fsc/13616 ("Major components for the manufacture of [guns] (i.e., firearms frames and receivers) should be controlled and appropriately marked upon manufacture.").

[130] The assumption may also be seen in defining smooth-bore handguns as NFA firearms. 27 C.F.R. § 479.11 (Westlaw 2012) (defining a smooth-bore handgun as an "any other weapon" subject to NFA regulation). The addition of rifling greatly increases range and accuracy and thus increases the effectiveness of the weapon (while bullets fired from a smooth bore do tumble, and thus can cause more damage upon impact, hollow point bullets, generally legal, have a similar effect). Yet the addition of rifling bypasses increased NFA scrutiny. The legislative motivation for the distinction, therefore, may be that rifled barrels, being difficult to make, represent industry involvement. Therefore, the rule creates an avenue to prosecute unsophisticated criminals who build crude firearms (sometimes referred to as "zip" guns).

[131] *See* KingLudd, *AR-15 Lower Receiver*, THINGIVERSE (Sept. 19, 2011), www.thingiverse.com/thing:11669 (digital CAD file).

[132] *See, e.g.*, Charles H. Chandler, *Gun-Making as a Cottage Industry*, 3 J. ON FIREARMS & PUB. POL'Y 155, 158-59 (1990) ("Many parts of a weapon, however, may appropriately be made of non-metallic materials, including various polymers; and a modern 9mm semi-automatic pistol, the notorious Glock 17, makes extensive use of high performance plastics. . . . Plastic magazines for some semiautomatic pistols are already on the market."); Paul Scarlata, *Shootout! Polymer Police Pistols*, GUNS AND AMMO.COM (Sept. 24, 2010), www.handgunsmag.com/2010/09/24/featured_handguns_polysh_032707/ ("Despite . . . dire predictions and downright hatred directed toward them, polymer-frame pistols quickly became the hottest items on the police handgun market. . . . And for good reason. Modern polymers provide equal, if not superior, resistance to wear, abrasion, solvents, oils and environmental extremes as steel and alloy-frame pistols.").

[133] *See supra* Part I.

[134] For example, DSM Somos, a leading manufacturer of materials for AM applications, boasts that its DXM-SL 100 resin can withstand the impact of a .22 caliber rifle. *DXM-SL: SL Accuracy, Sintered-like Durability*, DSM, www.dsm.com/en_US/html/dsms/dmx.htm (last updated Feb. 16, 2011).

[135] Terry Wohlers, *Viewpoint: History of Additive Fabrication (Part 2)*, WOHLERSASSOCIATES.COM (May-June 2008), http://wohlersassociates.com/MayJun08TCT.htm.

[136] KingLudd, *AR-15 Lower Receiver*, THINGIVERSE; *see also* CNC GUNSMITHING, www.cncguns.com/downloads.html (last visited Apr. 1, 2012) (digital adaptations of AR-15 CAD file not intended for use with 3D printers).

from bought or borrowed frames.[137] Those who choose to acquire guns in this way will go through no background check and leave no record of creation or distribution.

The ability to print frames could significantly affect how guns reach consumers. Firearm manufacturers could provide buyers with a frame's 3D digital blueprint and then sell them the other parts needed for the completed gun, avoiding the hassle of licensing and ATF oversight. In other words, they would be selling springs and other bits of metal, not "firearms." This situation is similar to the parts kits in *Halberstam* but it makes production even easier, since no metalworking tools and comparatively little technical knowledge will be required to complete the frame. Being immunized against civil liability, manufacturers presumably would also be shielded from civil actions arising from haphazard piecemeal distribution arrangements.[138]

Scholars may debate whether increased access by way of home-manufacture will necessarily increase crime. Some might see this new supply as a major potential source of guns available for criminal activity.[139] Others already argue firearms are so accessible to criminals under the current system that there exists no meaningful regulatory barrier to acquisition.[140] In any case, if this new method of production is adopted, lawmakers must face the reality that the frame no longer performs as the foundational regulatory component.

If regulators believe supply-based restrictions of firearms are worth sustaining until their last viable moment, they will need to alter the definition of "firearm" to include at least one essential gun component that is difficult for 3D printers to produce. The barrel, necessarily tightly

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[137] Michael Weinberg, *It Will Be Awesome if They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology*, PUBLIC KNOWLEDGE, Nov. 2010, at 1, *available at* www.publicknowledge.org/it-will-be-awesome-if-they-dont-screw-it-up ("An individual with a 3D scanner [is] able to scan a physical object, transfer the resulting file to a 3D printer, and reproduce it at will.").

[138] *See* Protection of Lawful Commerce in Arms Act, Pub. L. No. 109-92, 119 Stat. 2095 (2005); *see Congress Passes Prohibition of Qualified Civil Claims Against Gun Manufacturers and Distributors*, 119 HARV. L. REV. 1939, 1941 (2006) ("The operational text of the Act is brief yet effective. First, '[a] qualified civil liability action may not be brought in any Federal or State court.' Second, '[a] qualified civil liability action that is pending on the date of enactment of this Act shall be immediately dismissed by the court in which the action was brought or is currently pending.' A 'qualified civil liability action' is an action brought against a dealer, manufacturer, or trade association for damages resulting from the unlawful use of a firearm by another.'") (footnotes omitted). Because consumers are not legally required to assemble the complete firearms themselves, the parts could also be taken to a gunsmith or other knowledgeable third party for assembly.

[139] *E.g.*, Nicholas J. Johnson, *Imagining Gun Control in America: Understanding the Remainder Problem*, 43 WAKE FOREST L. REV. 837, 840 n.11 (2008) (citing authorities that contend stricter supply yields less crime).

[140] *See generally id*.

toleranced and thus far exclusively metal, appears to be the only candidate.[141] But this fix will be temporary if access to metal 3D printers increases, and it will be unable to reconstitute the complementary controls of the National Firearm Act, which lacks analogous components to fall back on.

B. PRINTING OF NFA WEAPONS

While the reclassification of a regular firearm to an NFA firearm can result by simply reconfiguring legal components,[142] the NFA's machinegun prohibition is a supply-oriented restriction that strives to control physical objects. Fully automatic firearms do not exist in large numbers in the civilian population,[143] and they are currently difficult for criminals to obtain.[144] However, there often is no difference in mechanical complexity between semi-automatic and automatic versions of the same firearm.[145] Three-dimensional printers will be able to build both the highly regulated small parts used to convert guns from semi-automatic fire to fully automatic fire and the special frames that

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[141] *See* Geoffrey Kolbe, *The Making of a Rifled Barrel*, FIREARMID.COM (July 2000), http://firearmsid.com/Feature%20Articles/RifledBarrelManuf/BarrelManufacture.htm ("The barrel of any firearm is [subject to pressures of] 50,000 pounds per square inch or more, and special steels are required to safely withstand these stresses."). Many bullets, which are measured in decimal inches (caliber), are sized to thousands of an inch, such as .308 caliber rifle rounds. *See also* Jon R. Sundra, *All About Barrels*, PETERSEN'S RIFLESHOOTER (Sept. 23, 2010), www.rifleshootermag.com/2010/09/23/gunsmithing_rsgunsmith1/ (discussing barrel tolerance on the order of a few thousandths of an inch); *Rifling*, WIKIPEDIA (Mar. 24, 2012, 2:18 AM), http://en.wikipedia.org/wiki/Rifling.

[142] *See, e.g.*, United States v. Thompson/Ctr. Arms Co., 504 U.S. 505 (1992) (firearm manufacturer sold collections of components that could be assembled into either a lawful rifle, lawful pistol, or unlawful NFA short-barreled rifle).

[143] Nicholas J. Johnson, *Supply Restrictions at the Margins of* Heller *and the Abortion Analogue:* Stenberg *Principles, Assault Weapons, and the Attitudinalist Critique*, 60 HASTINGS L.J. 1285, 1297 (2009).

[144] Being NFA firearms, machineguns may not legally be possessed by individuals without permits. They therefore do not readily circulate in the secondary market. In 1986, federal law froze the number of machineguns that could be registered by civilians at 240,000. Craig S. Lerner & Nelson Lund, Heller *and Nonlethal Weapons*, 60 HASTINGS L.J. 1387, 1405-06 & n.105 (2009).

[145] Many automatic versions of firearms have semi-automatic analogues. For example, the M16 and AK-47 both have semi-automatic versions available to consumers. Usually, only small modifications in the firing mechanism determine the difference between automatic and semi-automatic capability. *See, e.g.*, *AR-15 vs. M16 Parts*, AR15.COM, www.ar15.com/content/legal/AR15-M16Parts/ (last visited Apr. 19, 2012). It was at one time fairly difficult to make conversion parts. *See* David B. Kopel, *Rational Basis Analysis of "Assault Weapon" Prohibition*, 20 J. CONTEMP. L. 381, 392-93 (1994) ("According to the [BATF, semi-automatic weapons] are 'difficult to convert to automatic fire.' The conversion requires several hours work by a skilled gunsmith willing to commit a major felony. The gunsmith must also have access to expensive equipment, such as precision lathes.") (footnotes omitted).

accommodate those parts.[146] Currently produced by the industry exclusively for military and law enforcement, these components and thus automatic weapons will become easily available for the first time.

C. INEVITABLE OBSOLESCENCE OF SUPPLY RESTRICTIONS

The printing of complete guns could come about in several ways. Most directly, 3D printers could advance until capable of making the most intricate parts of current industrially produced designs. But other less obvious developments may also give rise to complete guns.

First, simpler pre-existing designs may be adopted to accommodate current printing technology. For example, the Colt 45 Liberator is an extremely simple handgun that was mass-produced during WWII.[147] Firing only a single shot before needing to be manually reloaded,[148] the gun was parachuted behind enemy lines (complete with cartoon instructions) to support anti-Nazi resistance fighters.[149] While outdated and commercially unavailable, guns of this rudimentary nature might be easier to produce in plastics than modern designs.[150] While an all-polymer firearm has yet to be created,[151] design has thus far been dependent on mass appeal, including catering to military and law enforcement markets that demand top-of-the-line weapons.[152] An all-plastic gun could easily meet the needs of brief confrontation, be it illicit or in lawful self-defense, even if the barrel had a mere two-shot lifespan.[153]

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[146] *See supra* note 86.

[147] Charles H. Chandler, *Gun-Making as a Cottage Industry*, 3 J. ON FIREARMS & PUB. POL'Y 155, 156-57 (1990); *see also FP-45 Liberator*, WIKIPEDIA (Mar. 30, 3:01 PM), http://en.wikipedia.org/wiki/FP-45_Liberator.

[148] *FP-45 Liberator*, WIKIPEDIA (Mar. 30, 3:01 PM), http://en.wikipedia.org/wiki/FP-45_Liberator.

[149] *Id.*

[150] *See id.* ("The FP-45 was a crude, single-shot pistol designed to be cheaply and quickly mass produced. The Liberator had just 23 largely stamped and turned steel parts that were cheap and easy to manufacture."). The schematics are also relatively simple. *See* RALPH HAGAN, THE LIBERATOR PISTOL (1996), *available at* www.gunknowledge.com/Documents/US%20Military/US_FP45_Liberator%20Blueprints.pdf.

[151] Jesse Matthew Ruhl et al., *Gun Control: Targeting Rationality in a Loaded Debate*, 13 KAN. J. L. & PUB. POL'Y 413, 425 (2004) ("[N]o completely plastic pistol has been produced. Plastic-framed pistols are, however, quite popular as they weigh much less than their steel-framed counterparts.").

[152] *See* Catherine Hinman, *Red Eye Arms Says It Has a Battle Plan*, ORLANDO SENTINEL, Dec. 4, 1988, *available at* http://articles.orlandosentinel.com/1988-12-04/business/0080450020_1_red-eye-byron-connally (describing attempt by gun maker Red Eye Arms to design plastic arms for the military).

[153] Charles H. Chandler, *Gun-Making as a Cottage Industry*, 3 J. ON FIREARMS & PUB. POL'Y 155, 158 (1990) ("[Plastics] material [in key components] might be good for one or two shots; but

Second, new firearm designs specifically made for 3D printers might leverage unprecedented geometrical shapes to more effectively employ principles of physics. For example, additive manufacturing enabled the production of more efficient engine cooling systems through intricate, previously unbuildable structures.[154] In other words, unfettered design may allow materials, previously thought inadequate, to suffice for even the most demanding firearm components.

Finally, advanced printing technology and simplified mainstream industrial design might intersect. Metal Storm has invented a gun that is little more than a barrel and a few electrical components; the bullets are stacked one behind the other and discharged with an electric current, obviating the need for both a firing mechanism and a complicated apparatus that cycles ammunition in and out of the chamber.[155] Despite a near absence of moving parts, the device fires at a faster rate than contemporary machineguns.[156] Theoretically, future generations of 3D printers capable of making circuit boards in tandem with barrels might be able to produce these mechanically unelaborated designs.

IV. THE SECOND AMENDMENT'S PROTECTION FOR HOME-MANUFACTURED FIREARMS

Compare "[A handgun] is easier to store in a location that is readily accessible in an emergency,"[157] *with* "What is to prevent you from

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accuracy and muzzle energy would be likely to decline rapidly with successive firings."); *cf.* DON B. KATES, JR., GUNS, MURDER AND THE CONSTITUTION: A REALISTIC ASSESSMENT OF GUN CONTROL, 57 (1990), *available at* www.guncite.com/journals/gun_control_katesreal.html ("[P]ot metal guns would not safely fire more than 100 to 200 shots. But that lower quality would far more than suffice to meet the demand for new and additional guns for crimes or self-defense.").

[154] Lisa Harouni, *A Primer on 3D Printing*, TED (Jan. 2012), www.ted.com/talks/lisa_harouni_a_primer_on_3d_printing.html; *see also The Printed World*, ECONOMIST, Feb. 12, 2011, at 78, *available at* www.economist.com/node/18114221 ("Compared with a [traditionally] machined part, the printed [airplane wing] is some 60% lighter but still as sturdy.").

[155] *Future Weapons: Metal Storm* (Discovery Channel television broadcast May 3, 2006), *available at* http://dsc.discovery.com/videos/future-weapons-metal-storm.html; *see* METAL STORM, www.metalstorm.com/component/option,com_frontpage/Itemid,79/ (last visited Apr. 1, 2012).

[156] *Future Weapons: Metal Storm* (Discovery Channel television broadcast May 3, 2006), *available at* http://dsc.discovery.com/videos/future-weapons-metal-storm.html ("There is basically only one moving part. And that's the bullet."). A 9mm Metal Storm handgun is capable of firing at the astonishing rate of 16,000 rounds per second (960,000 rounds per minute). The gun is, however, incapable of holding enough ammunition to fire at this rate for more than fractions of a second. *Id*. In comparison, the famous "minigun," known for its high rate of fire, shoots a mere 6000 rounds per minute. *Minigun*, WIKIPEDIA (Feb. 29, 2012, 8:19 PM) http://en.wikipedia.org/wiki/Minigun.

[157] District of Columbia v. Heller, 554 U.S. 570, 629 (2008).

> [printing] a toaster that squeezes into that oddly shaped nook in your kitchen?"[158]

The ability of 3D printers to produce firearm frames and ultimately complete guns will likely stimulate a new debate over firearm acquisition. As regulation of mainstream distribution becomes insufficient to control procurement, lawmakers might employ two broad strategies to discourage home-manufacture of firearms. The most obvious legislative response would be to criminalize the act of making or possessing homemade guns. More narrowly, new rules might ban firearms made by specific processes (e.g., additive manufacturing) or made from certain materials employed by those processes (e.g., plastics and powder-based metals).

The reduction of crime and gun violence are goals of utmost legitimacy. The current supply-side regulatory system, for all its longstanding faults, creates some acquisitional friction and should be held together for as long is it can. New laws might also focus on criminalizing the act of manufacture by prohibited individuals, or their possession of otherwise unrestricted firearm components. Enforcement should continue against all homemade guns not conforming to mandates of the National Firearm Act, such as those capable of automatic fire. There is, however, one strategy that should not be adopted: a blanket ban on home-manufacture of personal defense weapons.

Without propounding on the reasonable restrictions that may be appropriate or necessary to temper a right to build arms, responsible individuals who are not prohibited from owning firearms should be allowed to construct self-defense weapons, solely for personal use, that are analogous to models lawfully available in the primary market. The strong interests that support this right includes, among other things, the importance of choosing the device that one's life might depend on and providing the physically disabled with meaningful access to self-defense. While the existence of the right has been overlooked until now, the right is supported by English common law, our nation's history, analogous Sixth Amendment jurisprudence, and, most importantly, *District of Columbia v. Heller*.

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[158] Michael Weinberg, *It Will Be Awesome if They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology*, PUBLIC KNOWLEDGE, Nov. 2010, at 4, *available at* www.publicknowledge.org/it-will-be-awesome-if-they-dont-screw-it-up.

A. THE RIGHT TO BEAR (AND MAKE?) ARMS

The Second Amendment to the United States Constitution reads: "A well regulated militia, being necessary to the security of a free State, the right of the People to keep and bear arms, shall not be infringed."[159] The United States Supreme Court first interpreted the Amendment in *United States v. Miller*, a short, cryptic 1939 opinion that did little to clarify the Amendment's meaning.[160] Almost seventy years later, in *Heller v. District of Columbia*, the Court finally provided extensive treatment of the Amendment, this time holding that it guaranteed an individual right to own firearms.[161] Specifically, the Court struck down a ban on handguns, protecting their possession and defensive use within the home.[162] Justice Scalia's majority opinion used history as the "critical tool"[163] to find the "ancient" and "natural" right to bear arms,[164] also briefly justifying it as a barrier against tyranny.[165] Two years after *Heller*, in *McDonald v. City of Chicago*, the Court again applied historical analysis to find the right fundamental and thus applicable against the states through the Due Process Clause of the Fourteenth Amendment.[166]

The scope of this right remains unclear. First, it is not certain which weapons or activities will be initially considered for protection by a heightened level of judicial scrutiny. Firearms "in common use" at the time of consideration are protected, while "dangerous and unusual" weapons are not.[167] In what one scholar has called "dicta of the strongest sort,"[168] the Court used the common-use standard to exclude

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[159] U.S. CONST. amend. II.

[160] United States v. Miller, 307 U.S. 174, 177 (1939); Brian L. Frye, *The Peculiar Story of* United States v. Miller, 3 N.Y.U. J. L. & LIBERTY 48 (2008).

[161] District of Columbia v. Heller, 554 U.S. 570 (2008).

[162] *Id.* at 635-36.

[163] *Id.* at 570, 605.

[164] *Id.* at 599 ("The prefatory clause does not suggest that preserving the militia was the only reason Americans valued the ancient right . . . ."); *see id.* at 583 n.7, 585, 594, 612 (quoting sources proclaiming the right to bear arms as a natural right).

[165] *Id*. at 598, 599.

[166] McDonald v. City of Chicago, 130 S. Ct. 3020 (2010).

[167] *Heller*, 554 U.S. at 627 ("[T]he sorts of weapons protected [are] those 'in common use at the time.' We think that limitation is fairly supported by the historical tradition of prohibiting the carrying of 'dangerous and unusual' weapons.") (interpreting United States v. Miller, 307 U.S. 174 (1939)).

[168] Carlton F.W. Larson, *Four Exceptions in Search of a Theory:* District of Columbia v. Heller *and Judicial Ipse Dixit*, 60 HASTINGS L.J. 1371, 1372 (2009).

machineguns and other military weapons from protection.[169] In contrast, the Court explained that handguns are protected not only because of their widespread public adoption, but also because they include a number of attributes that an individual might find preferable or necessary to achieve effective self-defense.[170] Therefore individual autonomy, as with many fundamental rights, may be an important consideration in defining the scope of protection.

Second, once a weapon or activity is deemed to be within the scope of the Amendment, no level of scrutiny was articulated to analyze a given restriction.[171] The Court did make clear that per se bans on handguns, at issue in both cases, were impermissible "[u]nder any of the standards of scrutiny."[172] Yet *Heller* is a bittersweet victory for gun-rights advocates. Counter-intuitively, *Heller* may have solidified rather than disturbed the regulatory landscape.[173] Justice Scalia made clear that most current regulation would stand, naming several "presumptively lawful" historic areas of regulation.[174] Lower courts have thus far adopted intermediate scrutiny and applied it in an undemanding

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[169] *Heller*, 554 U.S. at 624 (describing as a "startling result" any interpretation of the *Miller* decision that would extent Second Amendment protection to machineguns); *id.* at 627 (indicating M16 assault rifles used by the U.S. military can be banned).

[170] *See id.* at 629.

[171] For analysis of potential standards, see Larson, *Four Exceptions in Search of a Theory:* District of Columbia v. Heller *and Judicial Ipse Dixit*, 60 HASTINGS L.J. at 1386 ("[T]he standard simply cannot be strict scrutiny, if the exceptions are taken as binding statements of the law. The exceptions can be easily justified, however, under a reasonableness standard, and possibly under an undue-burden or an intermediate-scrutiny test."); Mark Tushnet, Heller *and the Perils of Compromise*, 13 LEWIS & CLARK L. REV. 419, 431 (2009) ("[S]trict scrutiny is more compatible with the methodological approach Justice Scalia explicitly defends, intermediate scrutiny with the approach he explicitly criticizes."); Mark Tushnet, *Permissible Gun Regulations After* Heller*: Speculations About Method and Outcomes*, 56 UCLA L. REV. 1425, 1429 (2009) ("[Lower courts will choose] between intermediate scrutiny and rational basis with bite."); Ryan L. Card, Note, *An Opinion Without Standards: The Supreme Court's Refusal to Adopt a Standard of Constitutional Review in* District of Columbia v. Heller *Will Likely Cause Headaches for Future Judicial Review of Gun-Control Regulations*, 23 BYU J. PUB. L. 259, 286 (2009) ("The intermediate-scrutiny approach is the only standard not rejected by the Court . . . ."); Andrew R. Gould, Comment, *The Hidden Second Amendment Framework Within* District of Columbia v. Heller, 62 VAND. L. REV. 1535, 1570 (2009) ("[T]he Court has in mind or is likely to embrace a deferential form of strict scrutiny.").

[172] *Heller*, 554 U.S. at 628. The Court also hinted that it would be incorrect to review under the rational-basis standard. *Id.* at 628 n.27.

[173] Some have taken the position that *Heller* has no practical effect. *See* David C. Williams, *Death to Tyrants:* District of Columbia v. Heller *and the Uses of Guns*, 69 OHIO ST. L.J. 641, 657 (2008). ("Indeed, in practical terms, I am not at all sure what difference Heller will make except to confuse and inconvenience legislators."). Others have gone so far as to see *Heller* as a disaster for gun-rights advocates because it eliminates the slippery-slope argument that new gun regulation could lead to an all-out ban. Dennis A. Henigan, *The* Heller *Paradox*, 56 UCLA L. REV. 1171, 1210 (2009) ("Heller [is] perhaps the worst possible result for the gun lobby and the best possible result for gun control advocates.").

[174] *See Heller*, 554 U.S. at 626-27.

fashion.[175] With scant analysis,[176] district courts have upheld a host of gun laws against Second Amendment challenge.[177]

It is unclear to what extent *Heller* protects forthcoming weapons technology such as new designs or contemporary designs constructed with novel materials. The Court expressly extended protection to modern firearms.[178] Yet the common-use standard is imbued with circularity since new technology could be banned before wide public adoption.[179] The level of abstraction of the categories of common use may also be determinative of the right's robustness.[180] For example, to be deemed not in "common use," it is unclear if a gun must have a radical design or if mere inclusion of a novel alloy will suffice. Finally, it is unknown whether new materials and design will be seen as improving defensive utility, and therefore worthy of protection, or as "dangerous and unusual," and thus wholly outside the scope of Second Amendment protection. As Justice Breyer suggested in his dissent, many

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[175] Allen Rostron, *Protecting Gun Rights and Improving Gun Control After* District of Columbia v. Heller, 13 LEWIS & CLARK L. REV. 383, 406-07 (2009).

[176] Brannon P. Denning & Glenn H. Reynolds, Heller, *High Water(mark)? Lower Courts and the New Right to Keep and Bear Arms*, 60 HASTINGS L.J. 1245, 1259 (2009) ("[In district court opinions] one often sees little analysis—a grudging acknowledgement of Heller as a new fact of life, quickly followed by the conclusion that the case did not really change anything. And while lower courts sometimes lament the lack of clarity in Heller regarding, say, what the standard of review actually was, few judges seem interested in figuring it out on their own.") (footnotes omitted).

[177] Robert J. Cahall, *Local Gun Control Laws After* District of Columbia v. Heller*: Silver Bullets or Shooting Blanks? The Case for Strong State Preemption of Local Gun Control Laws*, 7 RUTGERS J. L. & PUB. POL'Y 359, 372-73 (2010) ("Thus far, federal district courts have upheld challenges to laws barring felons from possessing firearms, upheld a law prohibiting those under twenty-one from acquiring handguns from licensed dealers, and upheld a law prohibiting the possession of firearms by individuals convicted of a crime of misdemeanor domestic violence."); Rostron, *Protecting Gun Rights and Improving Gun Control After* District of Columbia v. Heller, 13 LEWIS & CLARK L. REV. at 404 ("In keeping with the Supreme Court's conclusion that the Second Amendment protects only weapons in 'common use' today, lower courts have rejected challenges to laws imposing special restrictions on possession of automatic weapons, sawed-off shotguns, and silencers.") (footnotes omitted).

[178] *Heller*, 554 U.S. at 582.

[179] *Id*. at 721 (Breyer, J., dissenting) ("On the majority's reasoning, if tomorrow someone invents a particularly useful, highly dangerous self-defense weapon, Congress and the States had better ban it immediately, for once it becomes popular Congress will no longer possess the constitutional authority to do so.").

[180] Nicholas J. Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. 1263, 1272 (2010) ("The open question is how far courts will credit the fine distinctions that are necessary to maintain restrictions on particular categories of technology. How small a difference in appearance, mechanics, or ballistics will sustain a separate regulated category? Spinning the analysis hard enough eventually makes every gun or brand of ammunition a category onto itself resulting in fewer categories large enough to satisfy the common use standard.").

attributes that make a weapon especially useful also make it "unusually dangerous."[181]

Whether a right exists to personally manufacture defensive weapons is constitutional terra nova. The Court has never mentioned or considered the right, and there is an absence of jurisprudence from state and federal courts.[182] Justice Scalia's sixty-three-page opinion has been accused of being vague, paradoxical,[183] and standardless.[184] The holding

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[181] *Heller*, 554 U.S. at 711 (Breyer, J., dissenting) ("[T]he very attributes that make handguns particularly useful for self-defense are also what make them particularly dangerous."); Nicholas J. Johnson, *Supply Restrictions at the Margins of* Heller *and the Abortion Analogue:* Stenberg *Principles, Assault Weapons, and the Attitudinalist Critique*, 60 HASTINGS L.J. 1285, 1302 (2009) ("Within the inventory of common firearms, each gun type has distinct utilities at the margin that make it more or less suitable as self-defense scenarios shift. . . . Thus the paradox: if the distinction is sound—if the ban is rational—it also is an admission of special utility. And that paradox poses a pivotal constitutional question.").

[182] Extensive searches of the Westlaw legal database uncover the following scant treatment: Gilbert Equip. Co. v. Higgins, 709 F. Supp. 1071 (S.D. Ala. 1989) (plaintiff alleged the right to bear arms included a right to manufacture arms, but the issue was not before the court and thus not decided); Mont. Shooting Sports Ass'n v. Holder, No. CV-09-147-DWM-JCL, 2010 WL 3926029, at *15 n.15 (D. Mont. Aug. 31, 2010) (plaintiff alleged fundamental right to manufacture and sell firearms under *McDonald*, but issue was not reached as it was improperly pleaded); Olympic Arms v. Buckles, 301 F.3d 384, 388-89 (6th Cir. 2002) (pre-*Heller*: "Sixth Circuit precedent does not recognize a fundamental right to individual weapon ownership or manufacture.").

[183] *Heller*, 554 U.S. at 721 (Breyer, J., dissenting); Craig S. Lerner & Nelson Lund, Heller *and Nonlethal Weapons*, 60 HASTINGS L.J. 1387, 1393 (2009) ("Scalia's test empowers Congress to create its own exceptions to the Second Amendment . . . ."); Adam Winkler, Heller*'s Catch-22*, 56 UCLA L. REV. 1551 (2009); Johnson, *Supply Restrictions at the Margins of* Heller *and the Abortion Analogue:* Stenberg *Principles, Assault Weapons, and the Attitudinalist Critique*, 60 Hastings L.J. at 1302.

[184] For analysis of potential standards, see Larson, *Four Exceptions in Search of a Theory:* District of Columbia v. Heller *and Judicial Ipse Dixit*, 60 HASTINGS L.J. at 1386 ("[T]he standard simply cannot be strict scrutiny, if the exceptions are taken as binding statements of the law. The exceptions can be easily justified, however, under a reasonableness standard, and possibly under an undue-burden or an intermediate-scrutiny test."); Mark Tushnet, Heller *and the Perils of Compromise*, 13 LEWIS & CLARK L. REV. 419, 431 (2009) ("[S]trict scrutiny is more compatible with the methodological approach Justice Scalia explicitly defends, intermediate scrutiny with the approach he explicitly criticizes."); Mark Tushnet, *Permissible Gun Regulations After* Heller*: Speculations About Method and Outcomes*, 56 UCLA L. REV. 1425, 1429 (2009) ("[Lower courts will choose] between intermediate scrutiny and rational basis with bite."); Ryan L. Card, Note, *An Opinion Without Standards: The Supreme Court's Refusal to Adopt a Standard of Constitutional Review in* District of Columbia v. Heller *Will Likely Cause Headaches for Future Judicial Review of Gun-Control Regulations*, 23 BYU J. PUB. L. 259, 286 (2009) ("The intermediate-scrutiny approach is the only standard not rejected by the Court . . . ."); Andrew R. Gould, Comment, *The Hidden Second Amendment Framework Within* District of Columbia v. Heller, 62 VAND. L. REV. 1535, 1570 (2009) ("[T]he Court has in mind or is likely to embrace a deferential form of strict scrutiny.").

Some have taken the position that *Heller* has no practical effect. *See* David C. Williams, *Death to Tyrants:* District of Columbia v. Heller *and the Uses of Guns*, 69 OHIO ST. L.J. 641, 657 (2008) ("Indeed, in practical terms, I am not at all sure what difference Heller will make except to confuse and inconvenience legislators."). Others have gone so far as to see *Heller* as a disaster for gun-rights advocates because it eliminates the slippery-slope argument that new gun regulation could lead to an all-out ban. Dennis A. Henigan, *The* Heller *Paradox*, 56 UCLA L. REV. 1171, 1210

is narrow; the Second Amendment protects the right to possess an operable handgun in the home.[185] But the Court's dicta are expansive.[186] These dicta and the underlying justifications for the right to self-defense are highly relevant (and indeed the Court's only Second Amendment jurisprudential guidance) in determining whether the right to bear arms extends to personal design and manufacture.

B. THE GENERAL RIGHT TO MANUFACTURE FIREARMS FOR PERSONAL USE

Heller can be interpreted to support a general right of individuals to manufacture their own firearms. At the most basic level, the Court implied the right to acquire arms. Under the Court's historical analysis, home-manufacture is not among the "presumptively lawful" exceptions to Second Amendment protection and indeed appears to be supported in our nation's tradition. *Heller* also indicates that individual autonomy, which would be greatly furthered by the right to home-manufacture, is important in determining the scope of the right to bear arms. Finally, the Second Amendment contemplates tyranny and anarchy, situations in which industrial production of arms, and thus normal channels of acquisition, would cease.

1. The Right to Acquire Firearms

As a threshold issue, *Heller* appears to protect not just the right to possess firearms but also the right to acquire them. The Court did not explicitly address acquisition but hinted it would reject regulation circumventing the end result of a user bearing an operable firearm.[187] The Court struck down a requirement in the challenged statute that

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(2009) ("Heller [is] perhaps the worst possible result for the gun lobby and the best possible result for gun control advocates.").

Brannon P. Denning & Glenn H. Reynolds, Heller, *High Water(mark)? Lower Courts and the New Right to Keep and Bear Arms*, 60 HASTINGS L.J. 1245, 1259 (2009) ("[In district court opinions] one often sees little analysis—a grudging acknowledgement of Heller as a new fact of life, quickly followed by the conclusion that the case did not really change anything. And while lower courts sometimes lament the lack of clarity in Heller regarding, say, what the standard of review actually was, few judges seem interested in figuring it out on their own.") (footnotes omitted).

[185] *Heller*, 554 U.S. at 635-36.

[186] Winkler, Heller*'s Catch-22*, 56 UCLA L. REV. at 1567 ("[I]n the upside down universe of Heller . . . the dicta are what really matter."); George A. Nation III, *The New Constitutional Right to Guns: Exploring the Illegitimate Birth and Acceptable Limitations of This New Right*, 40 RUTGERS L.J. 353, 413 (2009) ("The holding of Heller is limited to the home, however, dicta indicates a potentially much broader scope.").

[187] *See Heller*, 554 U.S. at 630 (striking down requirement that firearms be disassembled at all times).

firearms at all times be unloaded and disassembled, stating compliance "makes it impossible for citizens to use [guns] for the core lawful purpose of self-defense and is hence unconstitutional."[188]

Prohibiting acquisition of firearms disables the Second Amendment right no less than Washington D.C.'s invalidated disassembly requirement. Along these lines, scholars have interpreted *Heller* to protect not just the acquisition of guns,[189] but also access to ammunition[190] and proper training,[191] all three necessary to render guns effective self-defense tools. The Seventh Circuit, reasoning that the right to possess firearms implies the right to acquire them and maintain proficiency in their use, recently enjoined a ban on shooting ranges in Chicago along with other restrictions barring ambulation of weapons to such ranges.[192] It appears that the Court tacitly recognizes that some form of acquisition, even if heavily burdened,[193] is necessarily implied by the right to bear arms.

2. Historical Support and Lack of Longstanding Prohibitions

A cursory historical investigation supports the right to personally manufacture arms.[194] To find the individual right codified in the Second Amendment, Justice Scalia's "critical tool" was "*the public*['s] *understanding* of [the Second Amendment] in the period after its enactment."[195] That public understanding, especially as expressed by

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[188] *Id.*

[189] Eugene Volokh, *The First and Second Amendments*, 109 COLUM. L. REV. SIDEBAR 97, 99 (2009) ("Whatever such a right might mean, it must include the right to accomplish that core lawful purpose by acquiring the handgun."); Nicholas J. Johnson, *Supply Restrictions at the Margins of* Heller *and the Abortion Analogue:* Stenberg *Principles, Assault Weapons, and the Attitudinalist Critique*, 60 HASTINGS L.J. 1285, 1291 (2009) ("[P]ost-Heller, taking the supply to zero is explicitly constitutionally prohibited.").

[190] Nicholas J. Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. 1263, 1265 (2010) ("Even though Heller did not explicitly address ammunition, it would eviscerate the right to say that guns are protected but ammunition is not.").

[191] David C. Williams, *Death to Tyrants:* District of Columbia v. Heller *and the Uses of Guns*, 69 OHIO ST. L.J. 641, 648 (2008) (interpreting *Heller* as creating the right to buy guns and train with them); Michael P. O'Shea, *The Right to Defensive Arms After* District of Columbia v. Heller, 111 W. VA. L. REV. 349, 369 (2009) (explaining that the right also extends to regularly practicing with weapons so that they can be effectively used in self-defense).

[192] Ezell v. Chicago, 651 F.3d 684, 704-11 (7th Cir. 2011).

[193] Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. at 1273-74 ("The suggestion in Heller that many of the gun regulations now in place do not violate the Second Amendment signals that the Court will tolerate significant regulatory friction in the process of acquiring guns, so long as the core right is ultimately respected.").

[194] This Comment does not purport to do an exhaustive historical investigation.

[195] District of Columbia v. Heller, 554 U.S. 570, 605 (2008). Defining the Second Amendment's scope with history was affirmed in *McDonald* and recently applied by the Seventh

legal scholars in the time between constitutional ratification and the Civil War, was that the right to bear arms closely resembled the English right.[196] Justice Scalia limited the right in two respects. First, he supported the exception for dangerous and unusual weapons by citing directly to Blackstone's *Commentaries*, a legal treatise on English law written in 1769.[197] Second, in dictum, Scalia declared four generally permissible arms restrictions:

> [N]othing in our opinion should be taken to cast doubt on longstanding prohibitions on the possession by felons and the mentally ill, or laws forbidding carrying in sensitive places . . . or laws imposing conditions and qualifications on the commercial sale of arms.[198]

Without citing authority, Scalia identified these exceptions as "presumptively lawful regulatory measures"[199] to be historically justified "if and when" they come before the Court.[200] The scope of the right, therefore, is in theory defined historically.

The right to engage in the arms trade, not analyzed here, should be distinguished from a personal manufacturing right. Manufacturing arms for profit seems closely related to the last of Scalia's lawful regulatory measures, commercial sale. Despite this difference, the arms industries in both America and England are well documented and may provide some secondary evidence of the "public's understanding" to make and participate in making their own arms. Unlike the right to bear arms, however, the right to make one's own arms seems to have been perceived differently in the two countries during American colonial times.

During this period in England, it is unlikely the public believed they had a right to make their own firearms. From 1638 until after the American Revolutionary War, arms manufacture in England was controlled by a rigid guild system.[201] Importation and manufacture of guns required approval, under threat of imprisonment, by the guild

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Circuit. Ezell v. Chicago, 651 F.3d 684, 702 (7th Cir. 2011) (citing McDonald v. Chicago, 130 S. Ct. 3020, 3047 (2010)).

[196] *Heller*, 554 U.S. at 605-10. The Court looked to three other categories of public understanding: pre-civil-war case law, post-civil-war legislation and post-civil-war legal scholarship. *Id.* at 610-19.

[197] *Id*. at 627.

[198] *Id*. at 626-27.

[199] *Id*. at 626 n.6.

[200] *Id*. at 635.

[201] JAMES WHISKER, THE GUNSMITH'S TRADE 68-69 (1992); 1 J.F. HAYWARD, THE ART OF THE GUNMAKER 19-24 (1963).

bureaucracy.[202] The monopoly could exclude anyone from entering the trade—a power it often used to bar immigrants[203] and religious groups.[204] Moreover, European gunsmiths were highly specialized and, with few exceptions, a given gunsmith would produce only a single type of firearm component.[205]

America was different. The most striking contrast was the lack of a guild system.[206] While informal apprenticeships were customary, anyone, regardless of formal training, could profess to gunsmith.[207] States even offered cheap loans to encourage gunsmith startups.[208] After the Revolutionary War began, gun making became a geographically decentralized cottage industry, occurring both in cities and on the sparse frontier: almost every town had at least one gunsmith.[209] These smiths were well-rounded, as many—especially those operating on the outskirts of the colonies—built every part of firearms that they produced.[210] Many made their own tools.[211] With organized armories inaccessible to the frontier and low barriers to entering the trade in all regions, the public

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[202] WHISKER, THE GUNSMITH'S TRADE at 68-69.

[203] 2 HAYWARD, THE ART OF THE GUNMAKER at 24 ("The City of London, with its closely organized system of trade guilds, looked askance at skilled immigrants likely to compete with native craftsmen, and Monlong [, a foreign gunsmith], was precluded from practicing his trade . . . .").

[204] JOYCE LEE MALCOLM, TO KEEP AND BEAR ARMS: THE ORIGINS OF AN ANGLO-AMERICAN RIGHT 92 (1994).

[205] 2 HAYWARD, THE ART OF THE GUNMAKER at 16 ("[T]he later the date the more advanced did specialization within the [European] gunmaker's trade become. This applies with particular force to England in the late eighteenth century and thereafter.").

[206] WHISKER, THE GUNSMITH'S TRADE at 3 ("The guild system was not transplanted in America for a number of reasons. The spirit of liberalism and freedom mitigated against the acceptance of such rigid formalism in the training of apprentices and journeyman in America. Great distances and the ease with which apprentices could disappear into the frontier populated largely by rugged individualists made enforcement of the rigid guild rules difficult.").

[207] *Id.* at 6 ("Even those apprentices who had never completed an apprenticeship might enter the trade. No guild, union or government agency attempted to regulate the gun making business. . . . He need not take any examination. He need not present one of his guns to any examining board.").

[208] *Id.* at 79 ("States also offered loans to gunsmiths to set up to manufacture the guns the new nation so sorely needed.").

[209] *Id.* at 67.

[210] *Id.* at 5 ("In small shops one tradesman performed all operations required to make a gun. . . . There was no division of labor."); 2 HAYWARD, THE ART OF THE GUNMAKER at 273 ("The gun makers who turned out Kentucky rifles also differed from their European contemporaries in that, at any rate up to the late eighteenth century, they were capable of producing the whole gun."). *But see* THE COLONIAL WILLIAMSBURG FOUND., THE GUNSMITH IN COLONIAL VIRGINIA 45 (1974) ("The production of a firearm, a complex article, requires the skills of a number of different crafts to make the barrel, the lock, the stock, and the mountings. Each element requires not only different skills, but different equipment. Few gunsmiths possessed all these.").

[211] M. L. BROWN, FIREARMS IN COLONIAL AMERICA: THE IMPACT ON HISTORY AND TECHNOLOGY, 1492-1792, at 248 (1980) ("The colonial American gunsmith made many of his tools and occasionally purchased them from a blacksmith specializing in tool-making.").

could reasonably have understood a right to acquire arms through self-production.

While most early Americans chose not to manufacture their own firearms, they played an intimate role in designing guns they commissioned. Primarily, they chose the gunsmiths on whose craftsmanship they would rely.[212] But customers also made key design decisions, such as a gun's caliber and the powder weight required to fire,[213] and their resulting arms were highly personalized, for example by custom-fitting stocks.[214] This customer involvement in design faded only after the Civil War, with the advent of replaceable parts catalyzing the conversion of most cottage industry into assembly-line production.[215] Still, the cottage industry remained a significant source of American firearms into the 1870s.[216]

Under *Heller's* "longstanding prohibitions," there appears to be no support for excluding home manufacture from protection. Although the Court's list of exceptions was non-exhaustive,[217] no regulation, longstanding or otherwise, has controlled personal firearm manufacture.[218] Distinct from constraints on possession and commercial production, personal manufacture remains almost entirely unregulated.[219] Specifically, Congress has always defined a firearm "manufacturer" as

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[212] *See, e.g.*, LAWRENCE P. SHELTON, CALIFORNIA GUNSMITHS 1846-1900, at 5 (Cindy Sovenski ed., 1977) ("The customer usually had [shotguns] made to order by a local gunsmith because he had a greater faith in a particular gunsmith's ability at boring the barrels to give better pattern.").

[213] *See id.* at 5 ("Designing the rifle was not entirely up to the gunsmith, the buyer usually had his own ideas as to caliber, shape of stock or how highly it was finished."); WHISKER, THE GUNSMITH'S TRADE at 90 ("[Gunsmiths] freely contracted their services with customers, offering to each a custom made rifle tailored to the customer's dimensions and desires and pocketbook.").

[214] 2 HAYWARD, THE ART OF THE GUNMAKER at 302 ("The barrels having been received, the stock could be made. This necessitated a fitting for the customer.").

[215] WHISKER, THE GUNSMITH'S TRADE at vi.

[216] *Id.* at 67 ("Despite the growth of large industrial facilities for the manufacture of arms in the post Civil War era, the cottage industry remained a primary source of weapons until well after 1870.").

[217] District of Columbia v. Heller, 554 U.S. 570, 627 n.26 (2008).

[218] *See* BUREAU OF ALCOHOL, TOBACCO, FIREARMS & EXPLOSIVES, *Firearms Technology*, www.atf.gov/firearms/faq/firearms-technology.html (last visited Apr. 1, 2012) ("For your information, per provisions of the Gun Control Act (GCA) of 1968, 18 U.S.C. Chapter 44, an unlicensed individual may make a 'firearm' as defined in the GCA for his own personal use, **but not for sale or distribution**."). However, anyone building a firearm must still use the requisite number of domestic parts. 27 C.F.R. § 478.39 (Westlaw 2012). *See also* WHISKER, THE GUNSMITH'S TRADE at 90; JIMMY D. TAYLOR, AMERICAN GUN CULTURE: COLLECTORS, SHOWS AND THE STORY OF THE GUN 19 (2009) (displaying chart indicating that not a single word pertaining to arms appeared in federal statutes until 1894, and the first major piece of federal regulation appeared in 1934).

[219] *See supra* note 218. It is not, however, legal to make NFA firearms, as they may not be possessed without permits.

one who operates for "the principal objective of livelihood and profit."[220] Overall, it appears American history supports a general right to make one's own arms for personal use, without exception. Although English history differs from our nation's experience, it seems unlikely the Court would overlook pre-ratification American tradition in favor of Old-World guild practices rooted in protectionist monopoly.

3. Individual Autonomy and Preference

Many constitutional rights, especially those deemed fundamental, are justified by an individual's interest in autonomy.[221] While *Heller* and *McDonald* do not explicitly mention this interest, *Heller* suggests, by emphasizing the individual's preference in selecting self-defense weapons, that individual autonomy is important in determining the scope of the Second Amendment. After rejecting the argument that handguns could be banned if rifles were permitted,[222] Scalia stated:

> There are many reasons that a citizen may prefer a handgun for home defense: It is easier to store in a location that is readily accessible in an emergency; it cannot easily be redirected or wrestled away by an attacker; it is easier to use for those without the upper-body strength to lift and aim a long gun; it can be pointed at a burglar with one hand while the other hand dials the police. [223]

In other words, a person faced with assault, murder or being taken against his or her will, has a strong interest in deciding the characteristics of the defensive device in which to put faith.

Personal design and manufacture of weapons greatly furthers this conception of autonomy. Rather than accepting pre-packaged attribute bundles determined by marketability, personal design allows someone to choose without limitation the characteristics he or she believes are best suited to self-defense. For example, one could choose the internal

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[220] A person manufacturing firearms is "engaged in the business" if he or she "devotes time, attention, and labor to manufacturing firearms as a regular course of trade or business with the principal objective of livelihood and profit through the sale or distribution of the firearms manufactured." 18 U.S.C.A. § 921(a)(21)(A) (Westlaw 2012). The definition is similar for dealers and importers. "Principal objective of livelihood and profit" means "the intent underlying the sale or disposition of firearms is predominantly one of obtaining livelihood and pecuniary gain." 18 U.S.C.A.§ 921(a)(22) (Westlaw 2012).

[221] *See generally* Rogers M. Smith, *The Constitution and Autonomy*, 60 TEX. L. REV. 175 (1982).

[222] *Heller*, 554 U.S. at 629 ("It is no answer to say . . . it is permissible to ban the possession of handguns so long as the possession of other firearms (*i.e.*, long guns) is allowed.").

[223] *Id.* at 629.

mechanisms he or she feels are most reliable, or decide the right balance between a long barrel, which increases accuracy, and a short barrel, which decreases weight. These were the same sorts of considerations made by patrons of seventeenth- and eighteenth-century gunsmiths.[224] Similarly, the right to personally manufacture furthers individual autonomy by allowing a customized design to be accessible in an age without tradesmen. It also extends personal responsibility to the quality of the finished product, similar to responsibility exercised in choosing a gunsmith who had a reputation for quality work.[225]

Heller's discussion of why handguns may be preferable for defense also hints that autonomy is important because it permits a user to choose a weapon that ameliorates his or her physical disabilities, extending the right to more people. Unlike other constitutional rights, the right to "bear" arms is practically limited by physical constraints of both the user and the firearm design. While one who is mute has many ways to engage in free "speech," it is difficult for someone with missing fingers to exercise the right to defend themselves by "bearing" arms, and almost impossible for a quadriplegic to do so.

Blackstone's recitation of the common law, heavily drawn upon by the Court, directly linked the concepts of disability and self-defense. Blackstone explained that limbs threatened with debilitating injury could be defended with deadly force, even if life was not threatened, precisely because loss of their function meant privation of self-defense:

> A man's limbs (by which for the present we only understand those members which may be useful to him in a fight and the loss of which alone amounts to mayhem by the common law) [exist] to enable him to protect himself. . . . [They] are of such high value, in the estimation of the laws of England, that it pardons even homicide if committed *se defendendo*, or in order to preserve them.[226]

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[224] *See* LAWRENCE P. SHELTON, CALIFORNIA GUNSMITHS 1846-1900, at 5 (Cindy Sovenski ed., 1977) ("Designing the rifle was not entirely up to the gunsmith, the buyer usually had his own ideas as to caliber, shape of stock or how highly it was finished."); WHISKER, THE GUNSMITH'S TRADE at 90 ("[Gunsmiths] freely contracted their services with customers, offering to each a custom made rifle tailored to the customer's dimensions and desires and pocketbook.").

[225] *See, e.g.*, SHELTON, CALIFORNIA GUNSMITHS 1846-1900, at 5 ("The customer usually had [shotguns] made to order by a local gunsmith because he had a greater faith in a particular gunsmith's ability at boring the barrels to give better pattern.").

[226] 1 WILLIAM BLACKSTONE, COMMENTARIES *130. The Second Amendment should not be formulated as to abandon the traditional connection between self-defense and ones' limbs: Martial arts, and the common tools they utilize, are a compelling context in which to apply the principles of this Comment. There is no greater undertaking of self-reliance, responsibility, or autonomy than honing one's own body for self-defense. In June 2010, the Court hinted that Second Amendment might apply to these admirable avenues of protection. A martial artist challenged a New York

The right to design self-defense weapons helps alleviate the effect of disability with which the common law was concerned. For example, a custom design might allow someone with prosthetic limbs or missing digits to safely and effectively aim,[227] or self-defense weapons for quadriplegics might operate using eye-tracking technology.[228]

The Supreme Court recognizes a congruent autonomy interest: the right to defend *in propria persona* in court.[229] In *Faretta v. California*, the Supreme Court held that a criminal defendant has a constitutional right, under the Sixth Amendment, to represent himself or herself without government-appointed counsel.[230] The highly originalist opinion cited natural law[231] and "the inestimable worth of free choice."[232] Scalia recently reiterated this view: "What the Constitution requires is that a defendant be given the right to challenge the State's case against him using the argument *he* sees fit. . . . [A]t issue is the supreme human dignity of being master of one's own fate . . . ."[233] While *Faretta*'s right is procedural,[234] it arguably stems from the same natural right of self-preservation as does self-defense.[235] A principle of *Faretta* is that we

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statute illegalizing home possession of a nunchaku, a hand-to-hand weapon commonly used by martial arts practitioners. After the Second Circuit upheld the law, Maloney v. Rice, 554 F.3d 56 (2d Cir. 2009), the Supreme Court vacated the judgment in light of *McDonald* and remanded for consideration under *Heller*. Maloney v. Rice, 130 S. Ct. 3541 (2010).

[227] *See, e.g.*, OFFICE FOR THE SURGEON GENERAL DEPARTMENT OF THE ARMY, CARE OF THE COMBAT AMPUTEE 648 (2009), *available at* www.bordeninstitute.army.mil/published_volumes/amputee/amputee.html ("Most pistols can be modified and retrofit[ed] with oversized, compliant grips that improve control [for prosthetic users] . . . . Long guns, such as rifles, carbines, and shotguns, can [also] be safely controlled with prostheses [through modification].").

[228] *Cf.* Erika Jönsson, If Looks Could Kill—An Evaluation of Eye Tracking in Computer Games 38 (2005) (masters thesis, Royal Institute of Technology, Stockholm) (describing use of eye-tracking technology as an effective means to control first-person shooting video games).

[229] *See* Indiana v. Edwards, 554 U.S. 164, 187 (2008) (Scalia, J., dissenting) (describing the right of self-representation as serving the "dignity and autonomy" of the accused (citing McKaskle v. Wiggins, 465 U.S. 168, 177 (1984))).

[230] Faretta v. California, 422 U.S. 806 (1975). In recent years the scope of the right has been limited. In *Martinez v. California Court of Appeals*, 528 U.S. 152 (2000), the Court held that criminal defendants do not have the right to represent themselves on appeal. Similarly, in *Indiana v. Edwards*, 554 U.S. 164 (2008), the Court held that defendants suffering from severe mental illness, even where competent to stand trial, had no right to represent themselves. Still, *Faretta* remains good law. *Id.* at 178 ("Indiana has also asked us to overrule *Faretta*. We decline to do so.").

[231] *Faretta*, 422 U.S. at 830 n.39.

[232] *Id.* at 834.

[233] *Edwards*, 554 U.S. at 186-87 (Scalia, J., dissenting).

[234] Other scholars have drawn analogies between criminal procedural protections and the Second Amendment. *See* Michael Steven Green, *The Paradox of Auxiliary Rights: The Privilege Against Self-Incrimination and the Right to Keep and Bear Arms*, 52 DUKE L.J. 113 (2002).

[235] Erica J. Hashimoto, *Defending the Right of Self-Representation: An Empirical Look at the Pro Se Felony Defendant*, 85 N.C. L. REV. 423, 464 (2007) ("The first interest protected by the right of self-representation could be termed the right of self-preservation.").

have a right to rely upon our own skill and judgment when life and liberty are threatened—logic that applies whether jeopardized by a slow proceeding in a well-lit courtroom or a fast proceeding in a dark alley.

It might be argued that in most cases factory-made firearms are safer and more effective than homemade equivalents. As home manufacturing becomes more sophisticated this concern may abate. In the meantime, brilliant individuals should not be foreclosed from either improving upon off-the-shelf designs or manufacturing firearms to higher standards than the industry. *Faretta* dismissed the argument that it would almost always be better to accept court-appointed counsel: "It is not inconceivable that in some rare instances, the defendant might in fact present his case more effectively by conducting his own defense. Personal liberties are not rooted in the law of averages. The right to defend is personal."[236] Just as one has the constitutional right in court to defend *in propria persona*, one should not be forced to outsource design and construction of a mechanical device his or her life may depend upon.

4. Civic Justifications:[237] Resistance Against Tyranny and Protection from Lawlessness

Heller mentions resistance to tyranny as one of the primary reasons the Second Amendment was adopted,[238] although Scalia did not elaborate on its importance in the modern context.[239] This justification, the Court's use of which has been both criticized and lauded,[240] has been mentioned in federal court before. Chief Judge Alex Kozinski of the Ninth Circuit recently described the Second Amendment as a "doomsday

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[236] *Faretta*, 422 U.S. at 834.

[237] Michael P. O'Shea, *The Right to Defensive Arms After* District of Columbia v. Heller, 111 W. VA. L. REV. 349, 350 (2009) (explaining that some primary purposes of firearm ownership are "civic in nature, such as deterring tyrannical acts by the government [and] protecting against invasion or internal disorder").

[238] District of Columbia v. Heller, 554 U.S. 570, 598–99 (2008) ("[W]hen the able-bodied men of a nation are trained in arms and organized, they are better able to resist tyranny. . . . It was understood across the political spectrum that the right helped the secure the ideal of a citizen militia, which might be necessary to oppose an oppressive military force if the constitutional order broke down."). For a description of the various types of tyranny the Court may have been referring to, including oppression by both majorities and minorities, see Michael Steven Green, *Why Protect Private Arms Possession? Nine Theories of the Second Amendment*, 84 NOTRE DAME L. REV. 131, 172-84 (2008).

[239] David C. Williams, *Death to Tyrants:* District of Columbia v. Heller *and the Uses of Guns*, 69 OHIO ST. L.J. 641, 650 (2008). Resistance to tyranny was not revisited in the opinion, causing some doubt about its continued validity as a justification. *Id.* at 641 ("Scalia's opinion never hints that the right to resist tyranny might still be alive and well and relevant to the Amendment's interpretation . . . .").

[240] Carl T. Bogus, Heller *and Insurrectionism*, 59 SYRACUSE L. REV. 253, 253 (2008) (criticizing *Heller* as an "endorsement of insurrectionism").

provision" that provides a bulwark against oppressive government, adding, "[h]owever improbable these contingencies may seem today, facing them unprepared is a mistake a free people get to make only once."[241] While anarchy was not specifically addressed in *Heller*,[242] Congress, following Hurricane Katrina, recognized the heightened importance of self-defense during lawlessness by barring the federal government from confiscating firearms during emergencies.[243]

A hypothetical tyrant, faced with armed opposition, would conceivably shut down suppliers of civilian arms. Similarly, anarchy could disrupt industrial manufacture or distribution. The ability to make one's own weapons, spare parts and ammunition would be essential to sustain protracted resistance against tyranny or to obtain meaningful protection in times of anarchy.[244] Personal manufacture would support short-term conflicts by allowing people to arm themselves, and it would be necessary in longer conflicts when munitions might be cut off indefinitely.[245]

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[241] Silveira v. Lockyer, 328 F.3d 567, 570 (9th Cir. 2003) (Kozinski, C.J., dissenting from denial of rehearing en banc) ("The Second Amendment is a doomsday provision, one designed for those exceptionally rare circumstances where all other rights have failed . . . . However improbable these contingencies may seem today, facing them unprepared is a mistake a free people get to make only once.").

[242] The Court, while not addressing general lawlessness, referred to a "breakdown in constitutional order." *Heller*, 554 U.S. at 599.

[243] In the wake of Hurricane Katrina, New Orleans police, supported by the National Guard, confiscated firearms from citizens who remained in the storm-affected region. In response, Congress introduced the Disaster Recovery Personal Protection Act of 2006, which forbade the federal government from (and created a civil remedy for) taking private firearms during emergencies. H.R. 5013, 109th Cong. (2d Sess.). The findings of the act read: "In the wake of Hurricane Katrina, State and local law enforcement and public safety service organizations were overwhelmed and could not fulfill the safety needs of the citizens of the State of Louisiana." *Id.* § 2. The bill ultimately passed as an amendment of the Department of Homeland Security Appropriations Act of 2007, Pub. L. No. 109–295, § 557, 120 Stat. 1355.

[244] It has been argued small arms cannot counter weapons a tyrannical government would employ. Williams, *Death to Tyrants:* District of Columbia v. Heller *and the Uses of Guns*, 69 OHIO ST. L.J. at 660 ("In order to combat a [tyrant's army], the people will also need to use up-to-date military style weapons. A six-shot double action revolver, of the sort commonly used in home defense, will help little . . . ."). Similarly, in *Heller*, in the context of recognizing that many weapons suitable for self-defense are obsolete for military activity, Justice Scalia stated that "it may be true that no amount of small arms could be useful against modern-day bombers and tanks." *Heller*, 554 U.S. at 627. In opposition to this view, Don Kates, a prolific Second Amendment writer cited by the majority in *Heller* for other propositions, argues that common firearms are sufficient for resisting oppressive regimes, because civilian guerilla tactics would leverage small arms' utilities. Don B. Kates & Clayton E. Cramer, *Second Amendment Limitations and Criminological Considerations*, 60 HASTINGS L.J. 1339, 1352 (2009).

[245] *See* Charles H. Chandler, *Gun-Making as a Cottage Industry*, 3 J. ON FIREARMS & PUB. POL'Y 155, 156 (1990) (explaining that adoption of highly restrictive regulatory regimes could precipitate clandestine cottage industry firearm production); Nicholas J. Johnson, *Imagining Gun Control in America: Understanding the Remainder Problem*, 43 WAKE FOREST L. REV. 837, 845-47

C. THE RIGHT TO POSSESS FIREARMS MADE BY CERTAIN PROCESSES AND OF CERTAIN MATERIALS

> "[While] [t]he choice of fabrication method for a 'cottage' weapons industry . . . would appear to favor machining and investment casting . . . more elaborate technology, as available, might be used . . ."[246]

Congress might employ an entirely different approach to discourage production by 3D-printers: criminalize possession of weapons made by certain materials, such as plastics, or by certain processes, such as additive manufacturing. Congress might attempt this strategy for several reasons. Intuitively, these restrictions feel like traditional firearm regulation.[247] Legislators may also feel the firearm lobby would not protest if the regulations did not threaten any firearm model then existing.[248] Finally, if the Court does find a general right to personally build defensive weapons, legislators may feel this form of restriction is the only option short of restricting public access to AM technology.

However, under *Heller* it appears firearms cannot be excluded from protection merely because they exhibit novel characteristics. Scalia construed the term "arms" in the Second Amendment as including newly invented weapons: "Just as the First Amendment protects modern forms of communications, and the Fourth Amendment applies to modern forms of search, the Second Amendment extends, prima facie, to all instruments that constitute bearable arms, even those that were not in existence at the time of founding."[249] Further, Scalia cited two cases in which the First and Fourth Amendments applied to technologies unanticipated at ratification. In *Reno v. American Civil Liberties Union*, the First Amendment was held to protect communications over the Internet,[250] and in *Kyllo v. United States*, scanning homes using thermal

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(2008) (explaining that complete firearm bans would be ineffective because firearms can be easily made).

[246] Chandler, *Gun-Making as a Cottage Industry*, 3 J. ON FIREARMS & PUB. POL'Y at 161.

[247] *Cf.* T. Markus Funk, Comment, *Gun Control and Economic Discrimination: The Melting-Point Case-in-Point*, 85 J. CRIM. L. & CRIMINOLOGY 764, 764-65 (1995) (describing state restrictions on guns made of certain materials).

[248] 134 Cong. Rec. H3088 (daily ed. May 10, 1988) (statement of Rep. Staggers) ("I am sure the chairman will tell you that I am not a real fan of gun control, but this bill does not ban any current firearms.") (statement of Rep. Dingell) ("This compromise legislation represents the hard work of many individuals and organizations, including the National Rifle Association which supports adoption of its provisions.").

[249] *Heller*, 554 U.S. at 582.

[250] Reno v. ACLU, 521 U.S. 844 (1997).

imaging was held an unreasonable search.[251] The cited passage from *Kyllo* stressed the importance of crafting a constitutional rule that would account for future invasive technologies.[252] The Court's reliance on these cases suggests, at a minimum, that a weapon may not be excluded from Second Amendment protection solely because it represents a technological advance.

But Justice Scalia's sweeping language may not be as robust as it first seems. In his dissent, Justice Breyer criticized the protection of novel weapons as illusory, since new guns can be banned before they gain protected status.[253] In other words, Congress has the power to prohibit possession of a new weapon—and presumably prevent its dissemination—before it becomes distributed widely enough to satisfy the Court's "common use" standard.[254]

Assuming Congress expeditiously bans guns made by additive manufacturing, two key inquiries will decide whether these arms fall within the scope of the Second Amendment (and thus whether the laws restricting them will be subject to more stringent judicial review than under the rational-basis standard). The first determination will be the permissible level of abstraction for "common use." More important, but closely related, is whether the Court will consider the novel design characteristics and materials of guns made by AM as features promoting defensive utility or as innovations that are "dangerous and unusual."

1. The Meaning of "Common Use"

In order for possession of printed guns to be protected under the Second Amendment, those guns must meet *Heller's* core standard of being in "common use" at the time of inquiry.[255] Guns not in common use, those "dangerous and unusual," will not be shielded by the Court's heightened scrutiny.[256] Scholar Nicholas J. Johnson identifies the key

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[251] Kyllo v. United States, 533 U.S. 27 (2001).

[252] *Id.* at 35-36 ("While the [thermal imaging] technology used in the present case was relatively crude, the rule we adopt must take account of more sophisticated systems that are already in use or in development.").

[253] *Heller*, 554 U.S. at 721 (Breyer, J., dissenting) ("On the majority's reasoning, if tomorrow someone invents a particularly useful, highly dangerous self-defense weapon, Congress and the States had better ban it immediately, for once it becomes popular Congress will no longer possess the constitutional authority to do so.").

[254] *Id.*; Craig S. Lerner & Nelson Lund, Heller *and Nonlethal Weapons*, 60 HASTINGS L.J. 1387, 1393 (2009).

[255] *Heller*, 554 U.S. at 627.

[256] *See id.* While it is not exactly clear how these two categories relate to one another, it appears they are mutually exclusive. *See* Lerner & Lund, Heller *and Nonlethal Weapons*, 60

question: "How small a difference in appearance, mechanics, or ballistics will sustain a separate regulated category?"[257] In other words, the appropriate level of abstraction at which to distinguish one weapon from another has yet to be determined. Broad categories would extend protection to some highly restricted NFA firearms.[258] On the other hand, if drawn too narrowly, the constitutional inquiry becomes tangled in detailed mechanical analysis that unworkably turns each firearm model or component into its own category.[259] In support of drawing moderately narrow categories, the Court suggested that bans based on barrel length[260] and rate of fire[261] are valid. Yet the holding simply refers to "handguns."[262]

If protections are drawn broadly—for example "semi-automatic rifles"—then rifles made by AM would seem to be protected as long as they are incapable of automatic fire and sufficiently conventional in design as to fall within the definition of a rifle. But by affirming *Miller*'s holding that the NFA's restrictions are constitutional, *Heller* indicates that these categories must be more complex.[263] For example, taking into

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HASTINGS L.J. at 1392 ("'[D]angerous and unusual' . . . appears to include all weapons that are not in common use by civilians today.").

[257] Nicholas J. Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. 1263, 1272 (2010); Nicholas J. Johnson, *Supply Restrictions at the Margins of* Heller *and the Abortion Analogue:* Stenberg *Principles, Assault Weapons, and the Attitudinalist Critique*, 60 HASTINGS L.J. 1285, 1293 (2009) ("Heller's common self-defense criteria suggests at least two obvious ways to qualify: A gun might be common because it is widely owned—for example, a Remington shotgun with sales in the millions. A gun might also be common because it is functionally the same as other common guns—for example, a custom-made shotgun that operates just like the widely-owned Remington.") (citation omitted); *see also* Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. at 1270-71.

[258] For example, if the category were "semi-automatic handguns," then smoothbore handguns, currently NFA firearms under heavy restrictions, would be protected. Scalia suggested that the NFA firearm restrictions (which include stringent registration requirements) might be unlawfully burdensome. *Heller*, 554 U.S. at 624 (suggesting that if machineguns were within the Second Amendment's protected class of firearms, the current NFA restrictions on them might be unconstitutional).

[259] Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. at 1272 ("Spinning the analysis hard enough eventually makes every gun or brand of ammunition a category onto itself resulting in fewer categories large enough to satisfy the common use standard.").

[260] *Heller*, 554 U.S. at 625 ("We therefore read *Miller* to say only that the Second Amendment does not protect those weapons not typically possessed by law-abiding citizens for lawful purposes, such as short-barreled shotguns.").

[261] *Id.* at 624 (suggesting that it is a "startling result" to conclude machineguns are protected).

[262] *Id.* at 635 ("In sum, we hold that the District's ban on handgun possession in the home violates the Second Amendment . . . .").

[263] *Id.* at 623 ("We therefore read *Miller* to say only that the Second Amendment does not protect those weapons not typically possessed by law-abiding citizens for lawful purposes, such as short-barreled shotguns.").

account the NFA's restrictions on rate of fire and barrel length, the category of protected weapons would be "semi-automatic rifles not having short barrels." It is difficult to say what underlies these carve-outs and what, apart from Congress's prerogative, determines whether one can be legitimately appended to "rifle." However, after *Heller* it appears, and it would be logical, if they were based on functional features deemed dangerous and unusual.[264] Guns made using AM, then, would be extended protection so long as the new features are not deemed to exhibit one of these qualities.

2. Calibrating "Common Use" by Determining "Dangerous and Unusual"

Scalia's majority opinion in *Heller* gives little guidance as to the meaning of "dangerous and unusual."[265] Indeed, weapons of any variety are, by definition, dangerous. Perhaps, then, the purpose of the Court's standard is to isolate weapons with inordinate deadliness compared to their legitimate defensive utility.[266] If the Court recognizes this logical distinction, otherwise lawful designs made on 3D printers will initially be extended Second Amendment protection.

There are several attributes primarily responsible for a gun's deadliness: "muzzle energy," determined by the speed and mass of the bullet;[267] additional traits of a bullet such as its material composition or shape that might, for example, allow it to pierce armor or expand upon

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[264] *But see* Johnson, *Administering the Second Amendment: Law, Politics, and Taxonomy*, 50 SANTA CLARA L. REV. at 1272 (explaining that while common-use distinctions based on function are most logical, the common-use standard is subject to manipulation and symbolic distinctions have sometimes prevailed).

[265] The historical sources in Scalia's string cite, all over a century old, recite this common-law standard without explaining which weapons qualify. *See Heller*, 554 U.S. at 627. Nelson Lund, Professor at George Mason School of Law, accuses Scalia of contorting the common-law prohibition on carrying weapons in a way that will alarm people (the crime of "affray") into a prohibition on their mere possession. Nelson Lund, *The Second Amendment,* Heller, *and Originalist Jurisprudence*, 56 UCLA L. REV. 1343, 1362-67 (2009).

[266] *See* Mark Tushnet, Heller *and the Perils of Compromise*, 13 LEWIS & CLARK L. REV. 419, 427 (2009) ("Why do M-16s fall within the category of 'dangerous and unusual weapons'? Again, the answer, at least as to dangerousness, has to come from some policy analysis and balancing: perhaps, for example, dangerous weapons are those that, while admittedly more effective in providing defense against assaults, pose significantly higher risks of harm when misused, and their greater effectiveness is outweighed by the higher risk.").

[267] Allen Rostron, *High-Powered Controversy: Gun Control, Terrorism, and the Fight over .50 Caliber Rifles*, 73 U. CIN. L. REV. 1415, 1422-23 (2005). While restrictions based explicitly upon muzzle energy appear nowhere in federal law, some states and many countries use this attribute to distinguish classes of firearms.

impact, increasing damage;[268] the rate of fire; and concealability. Most lawmakers would probably agree that these attributes are the ultimate object of gun control legislation.

In contrast, other features increase deadliness only tangentially, as a result of increasing accuracy or reliability. These include, among other things, extra grips and lightweight materials that allow a gun to be easier to handle and aim, [269] mechanical systems that increase dependability, and durable materials that lengthen the weapon's lifespan.[270] Justice Breyer pointed out that some features concurrently support both crime and lawful self-defense.[271] But *Heller*, by citing features analogous to those listed above in upholding handguns, erred on the side of constitutionality where overlap occurred.[272] These features, in other words, are more closely related to defensive utility than deadliness.

Rather than looking to whether a particular model of firearm or its components are in common use, it would be wise to focus on whether its deadly features are in common use. This formulation avoids drawing artificial distinctions between two models, designs, or configurations that are equally deadly. It also simplifies the constitutional inquiry, which could otherwise become mired in asking whether particular components or materials are common. The vast majority of current firearm regulation comports with, and can also be understood in terms of, this distinction. Machineguns fire too fast; weapons over fifty caliber have excessive muzzle energy; short-barreled rifles are too concealable per unit of firepower. This interpretation also avoids a narrow reading of common use that would anomalously leave tasers and other non-lethal weapons ineligible for heightened scrutiny because they are not, as distinct devices, in widespread defensive use.[273]

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[268] SPORTING ARMS & AMMUNITION MANUFACTURERS' INST., INC., A TECHNICAL OVERVIEW OF AMMUNITION TYPES, CHARACTERISTICS AND ISSUES 4-7 (2001), *available at* www.saami.org/specifications_and_information/publications/download/SAAMI_ITEM_226-A_Technical_Overview_of_Ammunition_Types_Characteristics_and_Issues.pdf.

[269] David B. Kopel, *Rational Basis Analysis of "Assault Weapon" Prohibition*, 20 J. CONTEMP. L. 381, 396 (1994) ("The major purpose of a pistol grip on a long gun is to stabilize the firearm . . . . The defensive application is obvious, as is the public safety advantage in preventing stray shots.").

[270] *See id.* at 401-02 (explaining that military-style rifles, while less powerful than sporting firearms, are more reliable, rugged and simple, making them easier to use and maintain).

[271] District of Columbia v. Heller, 554 U.S. 570, 711 (2008) (Breyer, J., dissenting).

[272] *Heller*, 554 U.S. at 629 ("It is no answer to say . . . it is permissible to ban the possession of handguns so long as the possession of other firearms (*i.e.*, long guns) is allowed.").

[273] *See* Eugene Volokh, *Nonlethal Self-Defense, (Almost Entirely) Nonlethal Weapons, and the Rights to Keep and Bear Arms and Defend Life*, 62 STAN. L. REV. 199, 220 (2009) (suggesting *Heller*'s dangerous and unusual standard does not exclude non-lethal weapons from protection).

This distinction between defensive utility and deadliness could be jurisprudentially accomplished by recognizing which weapons are in common use at a high level of abstraction: handheld projectile weapons readily capable of, but not vastly exceeding, the firepower required to stop a small number of aggressors at a reasonable distance.[274] Evidence would be objective and could even be broken down into handguns and long guns so as to fix the concealability variable.[275] For example, the upper boundary for long guns would be semi-automatic large-caliber hunting rifles. The Second Amendment would protect any semi-automatic long gun exhibiting muzzle energy and other ballistic properties below that threshold.[276]

There are, however, impediments to the adoption of this logical approach. First, historical discussions of dangerous and unusual weapons are rife with references to bans on Bowie knives.[277] It is difficult to distinguish this type of knife from any other based on deadliness, especially because swords were seen as lawful.[278] Bans on

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[274] *See* Don B. Kates & Clayton E. Cramer, *Second Amendment Limitations and Criminological Considerations*, 60 HASTINGS L.J. 1339, 1353 (2009) ("[T]he eighteenth-century understanding of the word "arms" was limited to weapons one could take in hand."); *cf. Heller*, 554 U.S. at 595 ("[W]e do not read the Second Amendment to protect the right of citizens to carry arms for *any sort* of confrontation, just as we do not read the First Amendment to protect the right of citizens to speak for *any purpose*.").

[275] There could even be a third category, disguised weapons. While all firearms disguised as innocuous objects might justly be banned, perhaps non-lethal weapons with deceiving appearances could qualify for protection because of their decreased deadliness.

[276] It would not be difficult for officers in the field to identify unusually powerful guns, as cartridge size practically determines the upper bound of muzzle energy. Specifically, muzzle energy is a function of the bullet's mass and velocity. *Muzzle Energy*, WIKIPEDIA (Apr. 25, 2012, 10:02 PM), http://en.wikipedia.org/wiki/Muzzle_energy. The initial peak velocity, before friction with the air affects the bullet, is primarily a function of two variables. First, bullet velocity depends on the magnitude of the chamber pressure generated when the gunpowder propellant rapidly turns from solid to gas; such pressure is directly proportional to the amount of powder in the cartridge. *See Muzzle Velocity*, WIKIPEDIA (Apr. 25, 2012, 10:06 PM), http://en.wikipedia.org/wiki/Muzzle_velocity. Second, the barrel length to a lesser extent influences bullet velocity, that is, the distance the pressure may act to accelerate the bullet. *Id*. By looking at the size of the cartridge and the length of the barrel, law enforcement would have a good idea of when further investigation is necessary.

[277] Kopel, *The Right to Arms in the Living Constitution*, 2010 CARDOZO L. REV. DE NOVO 99, 107-08 (2010) ("There were also cases testing what 'arms' were protected by the Second Amendment. The dominant line of cases held that militia-suitable arms (e.g., firearms, swords) were protected, but weapons that were supposedly useful only for brawling (e.g., Bowie knife, the Arkansas toothpick) were not. The right to arms was for all 'the people,' but the type of arms protected was governed by the introductory clause about the militia."). The Court, however, recently signaled some tolerance for otherwise unusual hand-to-hand weapons. *See supra* note 226.

[278] *Id.*; *see* English v. State, 35 Tex. 473 (1872) (man charged with carrying butcher knife to church challenged state law prohibiting carry of "dirks"; law upheld, as Second amendment "arms" includes sabers and other military weapons, not "dirks, daggers, slungshots [sic], sword-canes, brass-knuckles and bowie knives"), *cited in Heller*, 554 U.S. at 627.

Bowie knives might be reconciled with this new formulation if, like short-barreled rifles, their exclusion can be understood as inordinate power per concealability. Another impediment to the high-order conception of common use is that federal law and rules promulgated by the ATF have distinguished firearms at the component level for decades.[279] The primary example is the expired assault-weapon ban, which illegalized weapons having certain grips.[280] This practice, of course, is not dispositive of its own constitutionality, but legislative prerogative in categorizing weapons based upon components may be a protocol the Court does not see fit to disturb. This is especially evident from *United States v. Miller*'s deference to the NFA's bright-line test (then eighteen inches) for delineating ordinary shotguns from short-barreled shotguns subject to heightened controls.[281] Finally, a few states mandate minimum melting points for some firearm components, including the frame, in an effort to inhibit access to cheap "Saturday night special" handguns.[282] While designed for the industry, these restrictions go to the heart of the 3D printer question: if these restrictions are constitutional, there exists an avenue to ban AM weapons.

Assuming adoption of high-order common use and its underlying deadliness/defensive utility dichotomy, 3D printed guns not substantially deviating from current designs should initially be extended Second Amendment protection. The creation by additive manufacturing of otherwise lawful firearms will decrease weight, causing guns to be easier to aim, and make maintenance easier by allowing simple production of replacement parts. It will increase durability of many components by using newer, more durable materials. And, with minor design

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[279] For example, the ATF uses a "points" system to determine whether a given handgun may be imported. Points are awarded based on, among other criteria, the material the frame is made of and the adjustability of the gun's sights. BUREAU OF ALCOHOL, TOBACCO, FIREARMS & EXPLOSIVES, ATF FORM 4590 (revised Mar. 2008), *available at* www.atf.gov/forms/download/atf-f-5330-5.pdf.

[280] 18 U.S.C. § 922(v) (2000) (expired by sunset clause 2004).

[281] United States v. Miller, 307 U.S. 174, 178 (1939) ("In the absence of any evidence tending to show that possession or use of a 'shotgun having a barrel of less than eighteen inches in length' at this time has some reasonable relationship to the preservation or efficiency of a well regulated militia, we cannot say that the Second Amendment guarantees the right to keep and bear such an instrument. Certainly it is not within judicial notice that this weapon is any part of the ordinary military equipment or that its use could contribute to the common defense.").

[282] T. Markus Funk, Comment, *Gun Control and Economic Discrimination: The Melting-Point Case-in-Point*, 85 J. CRIM. L. & CRIMINOLOGY 764, 764-65 (1995) ("Illinois, for example, prohibits the sale of handguns having 'a barrel, slide, frame or receiver which is a die casting of zinc alloy or any other nonhomogeneous metal which will melt or deform at temperatures of less than 800 degrees Fahrenheit.' South Carolina and Hawaii have enacted laws virtually identical to Illinois, and Minnesota has enacted a similar law which has a 1000 degree melting point requirement and prohibits handguns with less than a certain 'tensile strength' . . . and handguns that are made of a powdered metal less than a certain density.") (footnotes omitted).

alterations, 3D printed firearms may even increase dependability of internal mechanisms.[283] On the other hand, it is unlikely that printers will soon increase the ballistic capabilities of firearms: production of high-quality barrels appears distant, and AM guns would probably continue to employ ammunition (responsible for many ballistic properties) that is commercially supplied.[284] On the whole, a gun made with a 3D printer that fires semi-automatically and is not overly concealable is no more deadly than any weapon available on the shelf.

In the non-technical sense, 3D printed weapons could be seen as "dangerous and unusual" in that, because they may become easy to produce, there is an increased danger to society. This concern, certainly valid, is not part of the present inquiry. The Court's test appears to focus on whether a particular weapon operates in a dangerous way in a given confrontation, not whether that particular model is used often in crime.[285] Bans could still be held constitutional if, despite 3D printed firearms being considered initially within the scope of the Second Amendment, the restrictions passed the Court's unarticulated standard of scrutiny that forms the second half of any constitutional challenge.

In the end, the Court's willingness to draw the distinction between deadliness and defensive utility may be determined before the AM issue manifests itself. Specifically, the issue may arise in challenges to restrictions on two other weapons categories: "assault weapons" and non-lethal weapons. The federal assault-weapon ban illegalized weapons based upon features almost all of which lacked any relation to deadliness.[286] Validity of similar restrictions would create the foundation for laws distinguishing at the low-order component or material level. Similarly, judicial review of non-lethal-weapon bans, restrictions of uncertain constitutional provenance, could indicate how

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[283] *Cf.* Lisa Harouni, *A Primer on 3D Printing*, TED (Jan. 2012), www.ted.com/talks/lisa_harouni_a_primer_on_3d_printing.html; *see also The Printed World*, ECONOMIST, Feb. 12, 2011, at 78, *available at* www.economist.com/node/18114221 ("Compared with a [traditionally] machined part, the printed [airplane wing] is some 60% lighter but still as sturdy.").

[284] While 3D printers could conceivably build custom cartridge casings and bullets, it is doubtful they will soon produce fully operable ammunition straight from the printer: there would seem to be technical difficulties in designing a printer that could deposit gunpowder, an unstable chemical agent, next to molten metal.

[285] *Cf.* District of Columbia v. Heller, 554 U.S. 570, 629 (2008) (analyzing handgun features for their usefulness in a confrontation). *But see id.* at 721 (Breyer, J., dissenting) ("[T]he very attributes that make handguns particularly useful for self-defense are also what make them particularly dangerous. . . . That they are small and light makes them easy to steal.").

[286] 18 U.S.C.A. § 922(v) (Westlaw 2012); David B. Kopel, *Rational Basis Analysis of "Assault Weapon" Prohibition*, 20 J. CONTEMP. L. 381 (1994) (criticizing state assault weapons bans, just prior to the passage of the analogous federal rules, as failing to meet rational-basis review).

far out courts are willing to draw the common-use line.[287] The aspirational language of Justice Scalia, the criticisms of Justice Breyer, and the constitutionality of 3D printed weapons may turn on these early cases.

CONCLUSION

> "[T]he technology is coming, and it is likely to disrupt every field it touches. Companies, regulators and entrepreneurs should start thinking about it now."[288]
>
> *But* "It is critical that those who fear [3D printers] not stop those who are inspired."[289]

Sustaining restriction on supply is impossible when an inexpensive machine can reproduce almost any physical object. Lawmakers may be able to slow the demise of the firearm regulatory system by redefining "firearm" to include parts that cannot (yet) be produced by 3D printers. But regulation of barrels, the most viable alternative, will probably be met with stiff resistance from gun-rights advocates and will have no effect on access to machineguns.[290]

The problem is not that the ship, whose sieve-like hull has always struggled to stay afloat with 300 million guns in its hold, is sinking. It's that we, as a nation, need to learn how to swim. While at first glance detrimental, even apocalyptic to some, the advent of additive manufacturing may have a positive influence by evolving how we confront violence and crime. Once supply restrictions are recognized as ineffective, new emphasis might be placed on improving impoverished communities and reexamining our drug policies in an effort to abrogate black markets. It will also hopefully refocus energy on bipartisan educational campaigns regarding the proper use, storage and

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[287] For a discussion of the constitutionally of non-lethal weapon bans, see Eugene Volokh, *Nonlethal Self-Defense, (Almost Entirely) Nonlethal Weapons, and the Rights to Keep and Bear Arms and Defend Life*, 62 STAN. L. REV. 199 (2009); Craig S. Lerner & Nelson Lund, Heller *and Nonlethal Weapons*, 60 HASTINGS L.J. 1387, 1405-06 & n.105 (2009).

[288] *Print Me a Stradivarius*, ECONOMIST, Feb. 10, 2011, at 11, *available at* www.economist.com/node/18114327.

[289] Michael Weinberg, *It Will Be Awesome if They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology*, PUBLIC KNOWLEDGE, Nov. 2010, at 1, *available at* www.publicknowledge.org/it-will-be-awesome-if-they-dont-screw-it-up.

[290] *See supra* text accompanying notes 142-46.

manufacture of self-defense weapons, with a special aim of reducing household accidents.

In the meantime, and while recognizing that some form of regulation may be necessary, blanket illegalization of home production is an inappropriate approach. While not yet exercised by many people, a right to build one's own self-defense weapons is worth recognizing. The right to bear arms in self-defense is distinguishable from other constitutional guarantees in a major way—it can be exercised only by those who can afford and physically wield firearms. After the Civil War, Colt famously advertised its handguns with the slogan, "Abe Lincoln may have set all men free, but Sam Colt made them equal."[291] The catchy phrase forsakes a deserving demographic. Personal manufacture practically extends the individual right to those who cannot afford to purchase a reliable gun and the disabled for whom Colt and their corporate brethren have little design incentive.

The right also puts our lives completely and literally in our own hands (if we are lucky enough to have them). When life is at stake *Heller* seems to defend an individual's preference in choosing a self-defense weapon. And in criminal trials, where the stakes are often just as high, the Court's analogous right of self-representation extends past the right to choose our attorney and allows us to build our own defense from scratch.[292] In the end it is the victim, much like the wrongfully accused criminal defendant, who lives with the outcome and therefore has the highest motivation to provide for his or her defense.[293]

The recognition of this right, precipitated by but distinct from the advent of 3D printed guns, should coincide with recognition of the defensive utility of otherwise lawful AM weapons. Stepping back from manufacturing technology, weapon legality should be based on features that are rooted in deadliness, not simply because a gun "looks scary" or is easier to acquire, use or repair. Of course, it will be some time before these benefits can be realized. Currently, AM has created a way to build firearm frames without being advanced enough to provide complete, highly customized quality weapons. Hopefully restrictions do not precipitate before lawmakers are cognizant of more sophisticated uses that advanced 3D printers will enable.

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[291] COLT, www.colt.com/ColtLawEnforcement/History.aspx (last visited Apr. 1, 2012).

[292] *See supra* text accompanying notes 229-36.

[293] *See* Faretta v. California, 422 U.S. 806, 819-20 (1975) ("The right to defend is given directly to the accused; for it is he who suffers the consequences if the defense fails.").

There are many unanswered questions and some glaring concerns. Because the ATF actively pursues technical violations,[294] it could be legally hazardous for otherwise law-abiding consumers to blunder into, and blindly bumble about, the labyrinth of federal firearm regulation. User injuries will probably result from amateur designs. There could be serious implications for our Fourth Amendment rights when guns are cheap, small and irregularly shaped.[295] Despite these pitfalls, the United States may be able to address these concerns more effectively than nations without developed gun cultures.

When lawmakers begin to debate AM, something much more important than firearms hangs in the balance. Frustrated by the ineffectiveness or unconstitutionality of novel acquisition restrictions, new restraints may move upstream to what they may see as the problem's headwaters: additive manufacturing itself. Advocates for 3D-printer regulation may find unlikely allies in the private sector. Convinced the printers will be used to churn out products with patented, trademarked or copyrighted elements, large intellectual property holders may clamor for protection from piracy and theft.[296] Even the firearm industry, a major lobbying force, would probably encourage regulation if advanced printers were diminishing their market share.[297] The hue and cry will be the anachronistic jealousies of the Stationers' Company, hoarders of additive manufacturing's two-dimensional forefather, and of the gun guilds of London.[298]

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[294] Jim F. Couch & William F. Shughart II, *Crime, Gun Control, and the BATF: The Political Economy of Law Enforcement*, 30 FORDHAM URB. L.J. 617 (2003) (empirical study confirming anecdotes that the ATF prosecutes minor technical violations made by otherwise law-abiding citizens).

[295] *Cf.* George M. Dery III, *Unintended Consequences: The Supreme Court's Interpretation of the Second Amendment in* District of Columbia v. Heller *Could Water-Down Fourth Amendment Rights*, 13 U. PA. J. L. & SOC. CHANGE 1, 3 (2009-2010) ("This Article . . . examines the possibility that, because of the promotion of the individual right to keep and bear arms, the Court might develop legal rules that ultimately limit individual protections under the Fourth Amendment.").

[296] *Print me a Stradivarius*, ECONOMIST, Feb. 10, 2011, at 11, *available at* www.economist.com/node/18114327 ("There are sure to be calls for restrictions on the use of 3D printers, and lawsuits about how existing IP laws should be applied."); Michael Weinberg, *It Will Be Awesome if They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology*, PUBLIC KNOWLEDGE, Nov. 2010, at 1, *available at* www.publicknowledge.org/it-will-be-awesome-if-they-dont-screw-it-up.

[297] *See* Jesse Matthew Ruhl et al., *Gun Control: Targeting Rationality in a Loaded Debate*, 13 KAN. J.L. & PUB. POL'Y 413, 417-18 (2004) (describing American firearm manufacturers' approval of import restrictions on cheap military surplus firearms that flooded the market following World War II).

[298] The Stationers' Company was a sixteenth-century English guild that held the royal monopoly on the printing press, an extremely lucrative charter that also aided the Crown in censoring publications. Noel Osborne, *The Stationers' Company and Copyright: A Brief*

While there is cause for concern, we must refuse to surrender free access to 3D printers and their feed materials. The new generation of 3D printers, able to print in multiple materials including metal, will make tools, toys, and car parts. The heat- and impact-resistant materials best suited for firearm construction will likewise build the strongest and safest consumer products. This industrial revolution will have no factories, workers or mass production: it will be about you, and what you would like to make. Implications for self-defense aside, severely restricting 3D printers will salt the roots of unknown art forms and prevent dissemination of an environmental ally. It might even prevent a parolee from printing a Stradivarius seeded with the hope of ascension from poverty.

Introduction, COPYRIGHT IN THE DIGITAL AGE, http://copyright-debate.co.uk/?p=184 (last visited Apr. 1, 2012) (official Stationers' Company website).