DIGITAL PEACEBUILDING

2025 Issue 1

3D Printing in the Illicit Arms Trade

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Executive Summary

The illicit arms trade undermines peace and public security, fueling violence and contributing to other illicit activities. Three-dimensional printing (3DP) technology amplifies the threat of the illicit arms trade by enabling non-state actors to manufacture unregulated, undetectable, and untraceable weapons. Although current structural and intellectual limitations in 3DP restrict its use for mass production, technological advancements in 3DP signal the increasing risks for its applications in the illicit arms trade, and a growing threat to public safety. Mitigating these risks necessitates strengthening international frameworks, establishing licensing requirements and mandates for 3D printers and their products, creating a global database of firearm designs, and deploying preventative software.

Introduction

The illicit arms trade significantly contributes to violence and criminality, undermining peacebuilding efforts and global security. Illicit weapons networks bypass regulated supply chains, allowing for the spread of dangerous weapons, without being subjected to any global verification systems. This lack of regulation on the weapons themselves or verification of the actors purchasing them contributes to global conflict. 3DP holds the ability to exacerbate these challenges by further enabling non-state actors to construct firearms outside of traditional regulatory frameworks, further decentralizing illicit weapons production.

Although, current 3DP methods are limited by material and technical limitations including durability, inconsistent precision, and reliance on metal, the rapid advancement of technology is quickly removing these constraints, making the use of 3DP weapons increasingly viable for illicit use.

This brief explores the ways in which 3DP can be used for illicit weapons manufacturing and smuggling, outlines the technological and legal gaps that facilitate its misuse, and presents targeted policy recommendations to proactively curb the use of 3DP in the illicit arms trade and its risks.

Overview: The Illicit Arms Trade

The illicit arms trade facilitates the unauthorized movement of firearms, firearm components and ammunitions, often across national borders.[1] Also referred to as "illicit arms flows", the illicit trafficking of small arms includes the diversion of weapons from legal to illegal markets within a nation.[2]

The trafficking and use of these illicit arms globally fuels conflict, violence, and repression, undermining peace and security, development, and humanitarian efforts.[3] These weapons that operate outside of traditional regulatory frameworks undermine state capacity through the deterioration of

1. United Nations. 2021. "Protocol Against the Illicit Manufacturing of and Trafficking in Firearms, Their Parts and Components and Ammunition, Supplementing the United Nations Convention Against Transnational Organized Crime." United Nations Treaty Collection.
2. Mercado, Guillermo Vazquez del, Ruggero Scaturro and Alex Goodwin. 2025. "Measuring the Scope and Scale of Illicit Arms Trafficking." Global Initiative Against Transnational Organized Crime.
3. Brehm, Maya. 2008. "The Arms Trade and States' Duty to Ensure Respect for Humanitarian and Human Rights Law." Journal of Conflict & Security Law. 12(3): 359-387.

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Editor: Dawn Brancati

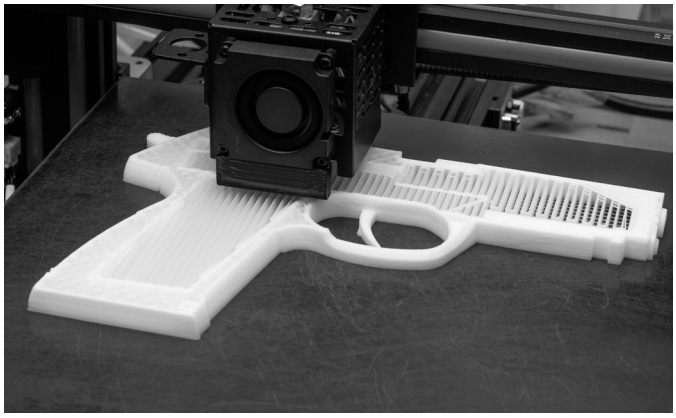
security and obstruction of law enforcement agencies enforcement abilities.[4]

Notably in both active and post-conflict regions, trafficked arms enable criminal organizations, armed groups, and terrorist networks to operate more effectively by evading legal restrictions.[5] These conflict settings can serve both as a source and destination for illicit arms trafficking with surplus weapon stockpiles and unsecured supplies from conflict zones being trafficked to other conflict zones or areas.[6] Even in post-conflict societies, illicit arms may remain, contributing to continued criminal activity and instability, ultimately undermining peacebuilding efforts.[6] Through these applications, the illicit arms trade uniquely both intensifies ongoing violence, and is itself perpetuated by conflict, forming a reciprocal dynamic between violence and weapons proliferation.[7]

The illicit arms trade poses a multifaceted threat to domestic and international security. Emerging technologies such as 3D printing may further facilitate the expansion of these illicit networks and their effects, by creating new, decentralized methods for weapon production and distribution outside the reach of existing regulatory oversight.

Overview: 3D Printing Technology

3-dimensional printing technology, also known as digital fabrication technology, creates physical objects by building up or carving away layers of material as designed by a digital model.[8] Overtime, advancements in 3DP have expanded the range of viable materials (polymers, metals, ceramic, biological, etc.)[9] and techniques (digital light process ing, laser sintering/melting, etc.)[10] that can be used, expanding possibilities for innovation. 3DP has been known to



Echt&Klreativ. n.d. “3D Printed Weapon Used for an Assassination Attempt Black and White.” https://stock.adobe.com/images/3d-printed-weapon-used-for-an-assassination-attempt-black-and-white/298133562?prev_url=detail

produce a wide range of products including automotive parts, houses, medical supplies, and others demonstrating its wide range of capabilities.[11] Additionally, 3DP is cost-effective for low-volume production and customized designs.[12] However, it is these same features that make 3DP attractive for misuse in areas such as the illicit arms trade.

Illicit Weapons Manufacturing & Smuggling

With the use of 3DP technology, illicit actors are able to produce fully 3D printed weapons that only require a basic hardware store nail as a firing pin, or hybrid 3D printed weapons that combine 3D components with unregulated metal parts that can oftentimes be found in a hardware store.[13] These weapons, often referred to as “ghost guns,” are untraceable.[14] Lacking serial numbers or other identification markers, 3DP ghost guns pose significant challenges for law enforcement agencies to trace specific guns to crimes or suspects, an attribute that is appealing for illicit actors.[15]

Currently, there is a lack of material regulation for 3DP materials used to print small arms. Many of

4. Andrade, Erin, Mark Hoofnagle, Elinore Kaufman, et.al.. 2021. “Firearm Laws and Illegal Firearm Flow between US States.” Journal of Trauma and Acute Care Surgery 88 (6):752-759.
5. United Nations. 2017. “Human Cost of Arms Trafficking ‘Runs Deep’, Disarmament Chief Stresses as Security Council Debates Halting Illicit Trade on ‘Dark Web’.” UN Press.
6. Pinson, Lauren. 2022. “Addressing the Linkages Between Illicit Arms, Organized Crime and Armed Conflict.” United Nations Office on Drugs and Crime: United Nations Institute for Disarmament Research.
7. Alwishewa, Hiruni. 2022. “Arms Exports to Conflict Zones and the Two Hats of Arms Companies.” Journal of Transnational Legal Theory 12(4): 527-549.
8. Lee, T.C., N. Shahrubudin, R. Ramlan. 2019. “An Overview on 3D Printing Technology: Technological, Materials, and Applications.” Procedia Manufacturing 35: 1286-1296. ; Mardis, Neil. 2018. “Emerging Technology and Applications of 3D Printing in the Medical Field.” Missouri Medicine 115(4):368-373.
9. Hewlett-Packard (hp). 2025. “A Complete Guide to 3D Printing Materials.” hp.com. ; Chia, Helena, Benjamin Wu. 2015. “Recent Advances in 3D Printing of Biomaterials.” Journal of Biological Engineering.
10. Jeong, Min, Kyle Radmonski, Diana Lopez, et.al.. 2023. “Materials and Applications of 3D Printing Technology in Dentistry: An Overview.” National Library of Medicine 12(1):1.
11. Chase, Ruby, Gerald LaPorte. 2017. “The Next Generation of Crime Tools and Challenges: 3D Printing.” National Institute of Justice.
12. Thomas and Gilbert. 2014. “Costs and Cost Effectiveness of Additive Manufacturing.” National Institute of Standards and Technology U.S. Department of Commerce.
13. Dent, Kyle, Yannick Veilleux-Lepage, Maria Zuppello. 2023. “Risks and Challenges in Online Communities for 3D-Printed Firearms Among Extremists and Terrorists.” Global Internet Forum to Counter Terrorism.
14. Williams, Samantha. 2024. “The Rise of 3D-Printed Guns: Technology and Implications.” cadmore.com.
15. Kshetri, Nir. 2025. “The Escalating Threat of 3D-Printed ‘Ghost Guns’.” governing.com.

Case Study: 3D Weapons in the Myanmar Conflict

In 2021, photographs circulated on various social media platforms showing members of the People's Defense Force in Myanmar holding 3D printed firearms. These weapons were identified as 3D printed semi-automatic pistol-caliber carbines, also known as FGC-9, a specific type of rifle. These rifles were originally designed by a member of an online 3DP firearms network, where blueprints for 3DP weapons are routinely uploaded. Notably, these 3DP firearms do not require any regulated components to manufacture, allowing actors in this conflict to produce firearms in almost any location while avoiding detection as long as they have obtained the relevant materials and equipment.

Source: Hartwig, N, M. Hassan, L. Pilkinton, L. Watson, C. Lloyd. 2024. "3D-Printed Firearms & Myanmar: Implications for Conflict and Security." Arquebus

3DP materials used to print small arms. Many of the the polymers, plastics and other lightweight materials used can serve broad purposes, exposing a regulatory gap that can make 3DP technology attractive for actors in the illicit arms trade.[16] Additionally, the use of non-metal materials in 3DP arms productions allows for the manufacturing of undetectable firearms that are able to bypass standard security screeners such as x-ray machines and metal detectors, increasing the risk posed by these weapons.[17]

"Striking a balance between fostering technological advancement and implementing robust regulatory measures is essential."[18]

The untraceable and undetectable nature of 3DP firearms makes them a significant threat to public safety and law enforcement efforts, while also making them increasingly attractive for illicit actors looking to circumvent regulatory barriers and evade law enforcement detection. Current systems do not adequately address these gaps in enforcement capabilities, highlighting the urgent need for enhanced regulation of 3DP technology in the context of weapons production.

The Expansion of Illicit Networks

3DP enables illicit actors to produce firearms without reliance on traditional supply chains, decentralizing weapons manufacturing and allowing for production to occur with minimal to no oversight.[18] The adaptability and cost-effectiveness of 3DP make it particularly appealing to nonstate actors that cannot obtain conventional arms due to regulatory or other barriers.[19] As technology continues to advance and 3DP production costs decline, it is likely that more illicit actors will look to incorporate 3DP methods into their illicit arms trade networks.[20]

A concerning aspect of the use of 3DP in the context of the illicit arms trade is the spread of digital blueprints for firearms. In an era characterized by growing global internet connectivity, the online distribution of 3DP firearm designs through social media and the "deep" and/or "dark web" by hard-to-trace accounts and extremist groups is becoming a growing trend.[21] This ease of access facilitates blueprint sharing across borders, further enabling unregulated weapons production by illicit actors.[22]

Without targeted policy interventions to address both decentralized manufacturing and the online dissemination of 3DP weapons, the spread of these "ghost guns" will likely escalate, further complicating future efforts to combat the illicit arms trade.

Regulatory Gaps

Existing national and international arms control frameworks contain significant gaps that prevent the effective regulation of 3DP weapons. A key regulatory challenge arises from the lack of explicit inclusion of 3DP firearms in arms control agreements. Although

16. Brockmann, Kolja. 2018. "3D-printable Guns and Why Export Controls on Technical Data Matter." Stockholm International Peace Research Institute.
17. Talbot, Thaddeus, Adam Skaggs. "Regulating 3D-Printed Guns Post-Heller: Why Two Steps are Better than One." The Journal of Law, Medicine & Ethics 48(2):98-104.
18. Sholademi, Damilola Bartholomew. 2024. "3D Printing and its Impact on Arms Proliferation." International Journal of Research Publication and Reviews 5(10):256-269.
19. Martin, Wes. 2021. "3D Printed Guns Fighting the Government in Myanmar." Grey Dynamics.
20. Pathak, Janhavi. 2025. "Print & Fire: Are 3D Weapons Transforming Threat Landscape?" Bloomsbury Intelligence & Security Institute.
21. Johnson, Chris. 2022. "Artificial Intelligence and Investigations of Illegal 3D Printed Weapons." Voyager Labs.
22. Hazarika, Monalisa. 2024. "3d Printed Firearms: Prospects for International Action in 2024." forumarmstrade.org.

some international instruments such as the UN Program of Action on Small Arms and Light Weapons, and the Arms Trade Treaty are aimed at curbing the spread of illicit weapons, they do not currently address the unique threats posed by 3DP weapons, leading to inconsistent regulatory approaches across nations.[23] Compounding this complication is the rapid pace of advancement in 3D technology, which makes it difficult for governments to update legislation and enforcement mechanisms quickly and effectively.[24]

Ineffective and non-standardized regulatory systems and insufficient enforcement mechanisms enable the continued operation of illicit trafficking.[4] For example, inconsistencies in regulation between states in the United States has allowed for illicit networks to operate across borders, negatively impacting even those states with stricter regulations,[4] demonstrating the need for policies similar to and expanding on those in the European Union that aim to place overarching uniform safeguards and security enhancements, to target criminal markets and reduce illicit arms trafficking and its impacts.[25]

"Firearm restrictions around the world can be circumvented."[13]

The current gaps in national and international arms control frameworks allow illicit actors to operate more easily and effectively, highlighting a significant flaw in structures aimed at combatting illicit arms trafficking. This demonstrates the urgent need for standardized global policies that will address these inconsistencies and strengthen enforcement efforts against the spread of illicit weapons.

The Limitations of 3D Printing for Illicit Arms Trafficking

While 3D printing holds potential to continuously contribute to the illicit arms trade, the technology also currently faces a number of limitations that can constrain its broader use in weapons production and trafficking:

Case Study: The "Liberator" 3DP Handgun

In May 2013 the blueprints for a 3DP handgun known as the "Liberator" were made available online. The "Liberator" is a one bullet handgun constructed from fifteen 3DP parts, and one metal piece, a standard hardware store nail that serves as the firing pin. Global law enforcement agencies have tested the weapon and determined it to be deadly, with the exact performance of the gun being dependent on the materials used to print.

Five days after the Liberator blueprints were posted online, the U.S. Department of State, Bureau of Political-Military Affairs, Office of Defense Trade Compliance instructed the creator to remove data files for the "Liberator", among others from the internet, after finding them to be in violation of the Export Control Act. The "Liberator" blueprints had already been downloaded an estimated one-hundred thousand times in only the first two days that they were accessible online.

Since the "Liberator", a number of new 3DP weapon blueprints have been shared on various online platforms and continue to grow more sophisticated in their designs over time.

Source: Walther, Gerald. 2015. "Printing Insecurity? The Security Implications of 3D-Printing of Weapons." Science and Engineering Ethics 21:1425-1445

Material limitations. Many consumer-grade 3D printers utilize thermoplastic polymers to create firearm components which lack the strength, durability, and heat resistance needed for essential components like barrels or firing pins.[14] To address these weaknesses, it is common for 3DP firearms to incorporate some metal components into their designs, which can often be sourced from hardware stores.[14] These limitations reduce structural integrity, making 3DP arms less accurate and more prone to malfunction, although law enforcement tests have demonstrated that fully or hybrid 3DP weapons can still operate effectively in limited uses.[13]

Technological Knowledge Requirements. Producing functional 3DP firearms requires a considerable amount of technical understanding. Proficiency in 3D modeling software is needed to modify or customize

23. Astroprint. 2024. "3D Printed Guns: A Growing Concern for Security and Legislation." astroprint.com.
24. Murphy, Colin. 2024. "Understanding EU Policy on Firearms Trafficking." European Parliamentary Research Service.
25. JLC3DP. 2024. "The Limits of 3D Printing: Comparison with Traditional Manufacturing." jlc3dp.com.

firearm blueprints, while an understanding of firearm mechanics aids to ensure proper operation post-production.[14] Furthermore, familiarity with 3D printer settings, post-printing steps for refinement and assembling, the ability to troubleshoot common printing issues, and skills in metalworking for hybrid weapons may be required to some extent.[14] These technical demands may currently act as a barrier for some illicit actors in contexts where expertise or specific tools are not readily available or easily accessible.

RJMendez. n.d. "3D Printed Ghost Gun." https://stock.adobe.com/images/3d-printed-ghost-gun/1152008016?prev_url=detail

Print Speed. The slow pace of 3D printing can provide another barrier to the mass production of 3DP weapons for the illicit arms trade. The additive construction of 3DP objects can be time consuming, especially when used for complex designs.[26] This limitation not only reduces the pace at which small arms can be produced, but also ultimately reduces the cost-efficiency for the mass production of illicit arms.[26]

Innovative Technology Restrictions. Regulatory countermeasures to prevent the use of 3DP for small weapons manufacturing also continues to evolve alongside advancements in 3DP technology. Companies such as 3DPrinterOS and MIX Lab have been developing software that uses artificial intelligence to detect and block print jobs of known designs for firearms and firearm components.[26] The wide-scale adoption of such systems would limit access to unauthorized 3DP weapon designs and restrict illicit production.

Policy Recommendations

As 3DP technology continues to advance, overcoming current barriers of use and expanding its potential for misuse through illicit arms production and trade, it poses new and dangerous threats to global security. The following recommendations aim to strengthen regulatory and enforcement capabilities to address the implications of 3DP in the context of the illicit arms trade:

- Develop an international legal framework that specifically addresses the unique threat posed by 3DP weapons and create a global standard for 3D printer regulations.
- Implement requirements for the licensing and registration of high-capacity 3D printers that are capable of producing firearms.
- Mobilize partnerships with 3D printer manufacturers to embed coding identifiers into 3D printed products similar to serial numbers.
- Standardize the use of software algorithms that detect and block the printing of known firearms and component designs across all 3D printer manufacturers.
- Form a global database of known firearm designs shared among law enforcement agencies and manufacturers to inform investigations and the prevention of 3DP firearms manufacturing.

A proactive and coordinated response through a combination of paralleled technological advancement, targeted laws and regulations, diplomacy and international cooperation offers a path forward that will support continued innovation, while mitigating the risks of 3DP in the context of the illicit arms trade.

26. Listek, Vanesa. 2024. "Daring AM: Software Advances Aim to Curb Illegal 3D Printing of Firearms." 3dprint.com.