Emerging Technologies: Challenges to WMD Export Controls

Jongsook Kim [a] , Byung-Woo Shin [a]
[a]*Korea Institute of Nuclear Nonproliferation and Control, 1418 Yuseong-daero 34010*

1. Introduction

In reviewing the history of the Weapons of Mass Destruction (WMD) non-proliferation regimes and the economic globalization, the efficiency of export controls is getting difficult more and more. Controls on exports of technology are a key component of the export controlled lists of the multilateral export control arrangements (MECA) such as Nuclear Suppliers Group (NSG), Missile Technology Control Regime (MTCR), Australian Group (AG) and Wassenaar Arrangement (WA) that are maintained by them.

But certain technologies, however, may not yet be listed on those lists, because they are emerging technologies. This paper will discuss on drones/ swarming technology and additive manufacturing (AM)/3D printing technology as emerging technologies particularly that present a threat and let us rethinking of existing export controls in nuclear nonproliferation efforts including other WMD like bio-chemical weapon and their delivery system.

2. Emerging Technologies: UAVs

In this and next section, some issues relevant to typical emerging technologies including AM/3D printing and drone technology will be described.

2.1 Drone as one of UAVs

Export control perspective, delivering systems of WMD normally divides into two groups: rocket systems such as ballistic missiles, space launch vehicles and unmanned aerial vehicles(UAV) including cruise missiles and drones. Though unmanned aircraft or UAV, remotely piloted aircraft systems (RPAS) and unmanned aircraft systems (UAS) are all different ways of referring to what are most commonly known as drones.

2.2 Export Controls on Drones

MTCR was established to prevent the proliferation of 'unmanned deliver systems' capable of weapons of WMD and governs the export of UAVs and separates the technology into Category I and Category II systems. Wassenaar Arrangement also intended to limit the proliferation of missile technology.

UAVs – depending on how they are designed and equipped – may present multiple security concerns beyond WMD delivery. For example, a fleet of small UAVs (that would fall outside of Category I) may have a highly lethal and highly evasive 'swarming' capability. Other concerning characteristics could include: high rates of speed, robust surveillance payload, low observable features and anti-aircraft countermeasures. The physical characteristics usually used to distinguish civil drones from military drones are;

- Operating range (from how far away they can by controlled)
- Take-off weight
- Payload (the weight a drone can carry out in addition to its own weight)
- Altitude above sea level at which they operate
- Endurance (how long they can be in the air)
- Command and control

Ranging from insect-sized to several tonnes in weight, drones are so versatile and can perform a very large variety of functions, from filming to farming and from medical aid to search/rescue operation. In this context, a challenge posed by the development of drone technology concerns export controls. This is particularly complicated in light of a dual-use nature of drone technology which means that with minor modifications a legitimate civil drone can be easily turned into an armed one.

Taking account of the concerns, EU updated the EU's dual-use regulations in 2019 and EU members committed to cooperate towards convergence of national arms export policies and to prevent exports of military technology (including drones) that could be misused by importers. But difficulties in enforcement exist because of matters of national sovereignty. And Wassenaar Arrangement covers all armed drones as well, it is deemed increasingly obsolete, given its inability to capture dual-use drones in its provisions.

2.3 Challenges

One of major concerns with controlling drones is drone swarm technology referred as one of emerging technology, which could have a significant impact on nuclear, biological and chemical weapon proliferation. Drone swarms could offer new means to improve existing nuclear delivery systems without being armed with a nuclear weapon both in defensive and offensive advantages.

In the same context, drone swarm technology is likely to encourage chemical and biological weapons proliferation and improve the capabilities of states that already possess these weapons. Terrorist organizations are also likely to be interested in the technology which has already shown interest in drone-based chemical and biological weapons attacks. Indeed, swarms have the potential to significantly improve chemical and biological weapons delivery. Sensor drones could collect environmental data to improve targeting, and attack drones could use this information in the timing and positioning for release, target selection and approach. For example, attack drones may release the agent earlier than planned based on shifts in wind conditions assessed by sensor drones.

Moreover, drone swarms enable the use of combined arms tactics. Some attack drones within the swarm could be equipped with chemical or biological payloads, while others could carry conventional weapons. Chemical or biological attack drones might strike first to force adversary troops into protective gear that inhibits movement, then follow up with conventional strikes. Although combined arms tactics are possible with current delivery systems, drone swarms allow much closer integration between conventional and unconventional weapons.

3. Emerging Technologies: AM/3D Printing

3.1 AM/3D Printing Technology

The additive manufacturing (AM) has been considered as a revolutionary technology in light of transforming supply chain and allowing the manufacture of items of great complexity at the same cost as more simple items.

The 3D printer in the nuclear industry is being used, for instance, for manufacturing metal lids for low-level waste containers in order to move waste at the Sellafield facility in the UK, and nuclear components for reprocessing plant and prototype fast breeder reactor at IGCAR at the Raja Ramanna Center in India.

3.2 Export Controls on AM/3D Printing

In spite of the great effect on economy, the effect on export control regimes may be also serious. AM/3D printing technology is not controlled currently, but materials for the nuclear fuel cycle such as carbon fibre, maraging steel, aluminium and plastics are controlled under NSG dual-use list are positively considered as suitable materials for producing sensitive items using AM technology at present.

However, materials such as uranium, plutonium, nuclear grade graphite, zirconium and beryllium which are controlled under NSG trigger list and dual-use list, however, are not suitable for 3D printing due to its chemical composition.

Items with many components, including some parts with special materials or complex moving parts with electronics are also not suitable, which are frequency inverter, pressure transducers, lasers, hot cells and remote manipulators that are subject to NSG dual-use list.

3.3. Challenges

Large number of metals are available for 3D printing including stainless steel, titanium, Inconel and maraging steel. Amongst them, maraging steel is most relevant material to the nuclear fuel cycle for use as components in a centrifuge to enrich uranium, specifically the rotor, baffles and endcaps. Other materials – carbon fibre and aluminium resistant to the high corrosive UF6 may be considered.

Considering the time to print a typical centrifuge rotor with current technology is an important benchmark for current applicability to the technology. An estimate of building for a typical metal printer is between 2~20mm3/s. Using an open source estimate of a centrifuge volume it would take about between 1.5 to 15 days to produce a centrifuge rotor at this rate of printing. According to the study, ten machines working in parallel would take a time between two weeks to half a year to produce 100 centrifuge rotors, with estimate likely to be on the conservative side due to the quality requirements of the product.

A digital file transfer as an email attachment can also provide the complete information needed to produce a physical item if a recipient has the 3D printer and the material. Controlling intangible technology transfers is an ongoing issue in the not only NSG but other export control arrangements.

In this context, it is worth discussing what other items from the Nuclear Supplier's Group (NSG) trigger list and dual-use list are suitable for 3D printing. Materials used for centrifuge rotor including carbon fibre, aluminium and plastics resistant to the high corrosive UF6 may be considered. It is doubtful whether the 3D printed materials would meet mechanical requirements under current status, because technical issues need to be solved be understanding 3D printing process, parametric refinement of existing procedures. But technology development process needs be monitored and discussed in advance.

4. Conclusions

WMD nonproliferation export control perspective, Misuse of drones for delivering nuclear, biological and chemical weapons is remaining challenges. AM/3D printing technology is also getting concerns under the same context in expanding uses of drone technology, it would be worth starting discussion and monitoring in NSG. Exploring new rules restricting the export of AM/3D printing and swarming-capable technologies needs to be started within the MECA framework.

REFERENCES

[1] IISS, Nuclear Black Markets: Pakistan, A.Q. Khan and the rise of proliferation networks, International Institute for Strategic Studies, Hastings Print, East Sussex, 2007.
[2] STIMSON, UAV Export Controls and Regulatory Challenges, Stimson Center, New York, 2015
[3] G. Christopher, 3D Printing: A Challenge to Nuclear Export Controls, STR, Vo. 1. No. 1, pp.18~25
[4] BIS Regulatory Agenda Includes New Mention of NPRM Related to Export Controls on 3D Printing.
[5] European Parliament, Civil and Military Drones – Navigating a Disruptive and Dynamic Technological Ecosystem, European Parliamentary Research Service. 2019