Section 6 Trends Concerning Military Science and Technology as well as Defense Production and Technological Bases

1 Military Science and Technological Trends

Recent developments in science and technology, in particular the dramatic advancement of Information and Communication Technology (ICT), has impacted a variety of areas, triggering significant, revolutionary changes in many areas such as economy, society, and lifestyle.

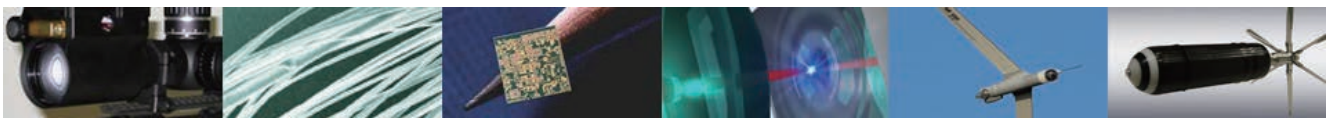
The military is no exception. Advanced countries, including the U.S., take the transformation triggered by the development of ICT as a factor enabling the dramatic improvement of combat and other capabilities, and continue to engage in a variety of research and policies.

In particular, the U.S. focuses on Network-Centric Warfare (NCW) as the direction for transformation of its armed forces. NCW captures information on enemy troops using information-gathering systems, including reconnaissance satellites and unmanned aircraft. The information is then shared on networks, enabling immediate command and control, even from remote headquarters; and enforces fast, precise, and flexible attacks against targets. This ensures further superiority in combat recognition capabilities in war space, as well as achieving more efficient combat operations.

The development of various media encompassing television, newspapers, and the Internet including social media, has enabled combat and damage situations to be broadcast across the world in real time, tending to make casualties caused by fighting and other events greatly impact society. This has required countries to minimize casualties of citizens and their own forces on the battle field. In response to these social trends, precise and effective attacks dedicated to military targets are required, and countries maintaining high-tech troops, including the U.S., work on improving the destructive capabilities of their weapons, precision guidance technology, information-related technology including C^4ISR, and unmanned technology (e.g. drones) to be able to carry out more precise and effective attacks. They also make emphasis on research and development activities on improved stealth capacity to increase opportunities for preemptive attacks, stealth technology for reducing risks for attrition of combat capabilities through improved survivability, and nanotechnology used for parts and materials related to these technologies. The Quadrennial Defense Review (QDR), published by the U.S. Department of Defense in March 2014, states that the proliferation of state-of-the-art technologies[1] will transform the mode of warfare.

Recent advancements in military science and technology are also largely attributed to the advancement of civil technology. As the capabilities of existing equipment are improved and new equipment is developed, spin-on and dual-use technology[2] based on civil technology have recently been leveraged frequently. In particular, ICT-related civil technology has been applied to a variety of equipments on a larger scale. The U.S. has a significant edge in the area of these state-of-the-art technologies, and it is being pointed out that the gap in military capabilities with its allies could constrain any joint operations.

On the other hand, countries having difficulty in possessing high-tech troops for technological and economic reasons, and non-state entities including terrorist organizations, will work on research and development on weapons and other equipment that will enable them to gain superiority in fighting against countries with state-of-the-art technology, and to illegitimately obtain technology through ICT or other means. In short, these countries and organizations tend to focus on asymmetrical combat measures that can be developed or obtained with relatively less cost, enabling them to attack their opponents' vulnerability without using conventional military capa-



The U.S. Defense Advanced Research Projects Agency (DARPA) conducts research on a variety of military technologies.
(DARPA website)

1 The QDR describes that such technologies include "counter-stealth technology" that used to require large budgets, "automated and autonomous systems as well as robotics" that already have a wide range of commercial and military applications, "low-cost three-dimensional printers" that could revolutionize weapons manufacturing and logistics related to warfare, and "biotechnology breakthroughs" that could make new ways of developing weapons of mass destruction possible. The report notes that it remains unclear how these technologies will manifest on the battlefield.

2 In the field of military technology, generally speaking, "spin-on" means applying civil technology into military technology, "spin-off" means technology application in the opposite direction, and "dual-use technology" means technology available for use in both areas.

bilities. These asymmetrical combat measures include weapons of mass destruction, such as nuclear, chemical, and biological weapons; ballistic missiles; terrorist attacks; and cyber attacks.

Going forward, advanced countries, including the United States, are likely to continue to further develop their state-of-the-art military science and technology. In contrast, countries and non-state entities pursuing asymmetrical combat measures will leverage civil technology and obtain technology in an illegitimate manner, to advance their level of military science and technology.

As asymmetrical combat measures may be spreading throughout the world, the research and development of technology[3] that responds to these asymmetrical threats is also recognized as an important challenge.

2 Trends Concerning Defense Production and Technological Bases

Recently, Western countries have in particular been facing difficulty in significantly increasing their defense budgets. On the other hand, the sophistication of military science and technology and the greater complexity of equipment, as explained by 1 above, have escalated development and production costs and raised unit prices for procurement, resulting in a reduced number of procured units. Under these situations, many foreign countries are working on a variety of initiatives in order to maintain and enhance their national defense production and technological bases.

Western countries have targeted for greater competitiveness, through realignment of their defense industry in response to the aforementioned situation related to national defense budgets. The U.S. has seen repeated mergers and integrations among domestic corporations, while Europe has experienced cross-border mergers and integrations of the defense industry, especially in Germany, France, the U.K., and Italy[4].

In response to escalating development and production costs, Western countries are also promoting joint development and production and technological collaboration related to defense equipment among their allies and partners. This move can be attributed to such factors as (1) splitting development and production costs, (2) expanding demands in all countries participating in joint development and production, (3) mutual complementarity of technologies, and (4) raising domestic technology levels by obtaining the latest technology.

Furthermore, an international logistic support system called "Autonomic Logistics Global Sustainment" (ALGS) was adopted for the maintenance of the F-35 fighter aircraft, reflecting the international collaboration for its development. This system enables all F-35 user countries to share its components globally. It is important to pay close attention to the establishment of such international frameworks for logistic support, and the progress of international joint development and production.

See Part IV, Chapter 1, Section 4-3 (Technological Cooperation with Institutions Overseas and Within Japan)

See Fig. I-2-6-1 (Examples of International Joint Development)

Many foreign countries have been exporting defense equipment overseas since the Cold War era, and many countries have recently been promoting a policy of overseas exporting. As defense equipment has faced a dramatic increase in its

Fig. I-2-6-1 Examples of International Joint Development

Equipment	Year development commenced	Year of unit deployment	Participating countries
Transport aircraft (A400M) 	1982	2013	8 countries including U.K., France, Germany, Italy, and Spain (the U.S. withdrew by 2003)
Fighter aircraft (Euro fighter) 	1986	2003	UK, Germany, Italy, and Spain
Fighter aircraft (F-35) 	2001	Unit not yet in operation	9 countries including U.S., U.K., the Netherlands, and Italy
Unmanned aircraft (Euro Hawk) 	2005	Joint development cancelled	U.S., Germany
Unmanned aircraft (nEUROn) 	2005	Unit not deployed	6 countries including France, Sweden, Italy, and Spain

3 They include BMD as well as technologies for countering ballistic missiles, terrorist attacks, cyber attacks, etc. as well as ICT.

4 Large corporations involved with the defense industry of Western countries have high defense business ratios in their total revenues. In particular, the U.S. and the U.K. have large corporations with most of their revenues attributed to the defense business.

development and production costs, countries intend to maintain and strengthen their domestic defense industry by expanding demands in foreign markets through overseas exports, and seem to leverage this as a certain diplomatic tool for expanding their influence in the export destination countries. In addition, countries such as China and the Republic of Korea have established the infrastructure required to manufacture weapons through their past imports of defense equipment and their improved capabilities in science and technology, enabling them to attain the status of an export country of affordable defense equipment and to increase their export volumes.

We have recently seen an increase of defense equipment exports targeting the Asia-Pacific region. It is pointed out that this is due to the economic growth of the Asia-Pacific region as well as the greater influence of China, disputes over territorial issues, response to enhanced military capabilities of neighboring countries, and so on.

See Fig. I-2-6-2 (Top Ranking Countries in Major Conventional Arms Export (2008–2012))

Fig. I-2-6-2 Top Ranking Countries in Major Conventional Arms Export (2008–2012)

	Country	Global shares in defense equipment export (%), 2008–2012	Comparison with 2003–2007 Export Values (%)
1	United States	30	+16%
2	Russia	26	+28%
3	Germany	7	-8%
4	France	6	-18%
5	China	5	+162%
6	United Kingdom	4	+1%
7	Spain	3	+136%
8	Italy	2	+20%
9	Ukraine	2	+49%
10	Israel	2	+17%
11	The Netherlands	2	-24%
12	Sweden	2	+25%
13	Switzerland	1	+14%
14	Canada	1	-7%
15	Norway	1	+211%
16	Republic of Korea	1	+50%
17	South Africa	1	+49%

Note: Based on SIPRI YEARBOOK (2013). Chart shows countries with shares over 1%.

Commentary

Trend of Expanding Development of Unmanned Vehicles

Ministry of Column DEFENSE

In recent years, the demand for unmanned vehicles is rapidly increasing not only in the field of military use but also in disaster relief, industry and agriculture field. Factors behind this include the fact that unmanned vehicles can conduct missions that are not suitable for human beings called 3D (Dangerous, Dirty, Dull), such as dangerous missions conducted in the airspace of the area occupied by the enemy, missions in the area contaminated by chemical substances and radiation, and dull missions such as long hours monitoring and surveillance. In addition, they are more cost-effective than manned vehicles for the following reasons: space and equipment for crew such as cockpit is not required; there is no need to secure the safety of the pilot; and it is possible to reduce the size.

One of the unmanned vehicles for military use is an unmanned aerial vehicle (UAV), which was initially used for aerial targets in training and reconnaissance purposes, and has been developed to a multi-purpose vehicle to conduct various missions and a vehicle for attack. Recently developed UAV include stealth type, carrier-based type, and ones equipped with supersonic flight capability. Other unmanned vehicles include Unmanned Ground Vehicle (UGV), Unmanned Maritime Vehicle (UMV), Unmanned Surface Vehicle (USV), and Unmanned Undersea Vehicle (UUV), whose usage has been expanding in land and maritime missions. These vehicles are developed and used for the same purpose as UAV. They are also developed and used in accordance with geographical features and usage, such as clearing land and naval mines, and responding to nuclear disaster[1]. Although previous types of unmanned vehicles were developed based on the platform for manned vehicles such as aircraft and cars, it is reported that in recent years more neo-futuristic platforms have been developed, including ones representing insects, walking with two legs like human beings, or walking with four legs like animals. With the progress of various technology including information and communication technology (ICT), it is expected that types of vehicles could shift from man-controlled type to fully autonomous type in future[2]. Such vehicle is called Lethal Autonomous Weapons System (LAWS)[3], which performs various tasks automatically ranging from target determination to attack. Analysts note that the advancement of artificial intelligence may lead to the deployment of LAWS in actual combat in the near future.

Amid the increasing demand for unmanned vehicles, the United Nations and the countries that use UAV have raised operational issues, such as violation of sovereignty caused by UAV flying over other countries, collateral damage caused by the attack by UAV, and mental fatigue of UAV pilots, and various measures have been discussed regarding these issues.

On the other hand, due to their characteristics, the utility of unmanned vehicles are widely recognized in many countries and it is expected that development and introduction of unmanned vehicles will be further promoted, instead of manned vehicles.

(Bipedal walking type unmanned vehicle: Boston Dynamics website)

1 During the aftermath of the nuclear disaster occurred at the Fukushima Dai-ichi Nuclear Power Station on March 11, 2011, the U.S. Forces dispatched the unmanned reconnaissance aircraft Global Hawk to conduct intelligence operation.
2 The current unmanned vehicles are also able to perform a certain level of autonomous activities such as travelling.
3 In May 2014, systems for controlling robotic weapons were discussed for the first time at an informal meeting of the United Nations Convention on Certain Conventional Weapons (CCW).