DAIO Defense AI Observatory

Intelligent National Defense Amid Strategic Ambiguity?

Defense AI in Taiwan

Kitsch Liao

DAIO Study 24|24

Ein Projekt im Rahmen von

dtec.bw
Zentrum für Digitalisierungs- und Technologieforschung der Bundeswehr

Finanziert von der Europäischen Union
NextGenerationEU

About the Defense AI Observatory

The Defense AI Observatory (DAIO) at the Helmut Schmidt University in Hamburg monitors and analyzes the use of artificial intelligence by armed forces. DAIO comprises three interrelated work streams:

- Culture, concept development, and organizational transformation in the context of military innovation
- Current and future conflict pictures, conflict dynamics, and operational experience, especially related to the use of emerging technologies
- Defense industrial dynamics with a particular focus on the impact of emerging technologies on the nature and character of techno-industrial ecosystems

DAIO is an integral element of GhostPlay, a capability and technology development project for concept-driven and AI-enhanced defense decision-making in support of fast-paced defense operations. GhostPlay is funded by the Center for Digital and Technology Research of the German Bundeswehr (dtec.bw). dtec.bw is funded by the European Union – NextGenerationEU.

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About the Author
Kitsch Liao is an assistant director of the Atlantic Council's Global China Hub. Prior to joining the Atlantic Council, Liao worked in the US Congress, in diplomatic postings, and as a cyber intelligence analyst for the private sector. He is also the cyber and military affairs consultant for Taiwan's Doublethink Lab. He has worked on various projects with the Australian Strategic Policy Institute, Institute of National Defense and Security Research, the US Department of Defense, and Janes on topics including Taiwan's order of battle; China's chemical, biological, radiological, and nuclear capability; and Chinese disinformation and cyber espionage operations. He received an MA in international affairs from Columbia University's School of International and Public Affairs and a BSc from Taiwan's National Chengchi University. His X/Twitter account is @KitschQuixote.

Acknowledgments
The author would like to thank Eric Lee, Crystal Tu, Heiko Borchert, Torben Schütz, and Joseph Verbovszky for their valuable comments and suggestions. The author is solely responsible for any errors in fact, analysis, or omission.

Design
Almasy Information Design Thinking

Imprint
Kitsch Liao, Intelligent National Defense Amid Strategic Ambiguity? Defense AI in Taiwan. DAIO Study 24/24 (Hamburg: Defense AI Observatory, 2024).

An adapted version of this paper will appear in: Heiko Borchert, Torben Schütz, and Joseph Verbovszky (eds.) The Very Long Game. 25 Case Studies on the Global State of Defense AI (Cham: Springer Nature, forthcoming).

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ISSN (online): 2749-5337
ISSN (print): 2749-5345

Content

1 Executive Summary

Taiwan's approach to defense AI suffers from the same issue plaguing its overall defense establishment: A legacy from an authoritarian past disconnecting the civilian government and defense establishment, inhibiting the effective strategic alignment to array the country's operational and tactical approach toward the Chinese threat in an asymmetric manner agreed upon by the country's political establishment and its primary security guarantor, the United States.

Such a disconnect also prevented the defense establishment from effectively leveraging Taiwan's impressive civilian technology innovation sector. Existing defense-AI programs tend to be piecemeal and unfocused and mostly aimed at "doing things cheaper and faster" instead of exploring new ways of doing business.

Even the rare attempt by the Taiwan Air Force to advance the future concept of operations (CONOP) incorporating AI as the centerpiece proved to be technically ambitious, organizationally far-reaching, yet conceptually ill-formed.

However, there is no shortage of ideas from the grassroots, within and without Taiwan's defense establishment. If the country finds a way to funnel grassroots talent and solutions more effectively into a more open defense innovation ecosystem, Taiwan stands to benefit significantly from the adaptation of defense AI in contending its primary threat posed by China.

2 Thinking About Defense AI

2.1 Taiwan's Unique Security Situation

To discuss Taiwan's approach to defense AI, we first have to discuss Taiwan's general approach to the country's defense. Since the Nationalist Kuomintang (KMT) government retreated to Taiwan, Taiwan's military has always been, much like their Communist cousins on the mainland, loyal to the Party and its leader. This means that instead of a dialectic process informing a national defense strategy, such a strategy was often decided within a relatively small circle surrounding the leadership. In turn, this created a situation where the armed forces were relatively competent operationally and tactically yet lacked the capacity and culture to conduct strategic planning and foresight.

Today, Taiwan's defense still suffers much from this authoritarian legacy. Perhaps the most relevant issue of this concerning legacies lies in the mismatched strategic, operational, and tactical objectives for Taiwan's defense strategy. This further influences force structure, training, research, development, and acquisition. And the advent of defense artificial intelligence (AI) as an issue of significance cannot escape this inevitable trend.

The situation is further exacerbated by Taiwan's lack of international space due to China's relentless effort to coerce all other countries from maintaining official relations with Taiwan, let alone arms sales. Thus, with few exceptions, the US has remained the sole source of acquiring defense systems for the beleaguered island nation.

These arms sales, along with the Taiwan Relations Act, where the U.S. promises to maintain its ability but not intent to intervene should China invade, constitute a rather shaky promise toward Taiwan's security from its largest and, realistically, the only security partner in the world.[1]

What this means is that Taiwan is a country that does not get to decide its own future. Instead, the largest piece of its security strategy is in a constant state flux, aptly termed "strategic ambiguity," where the US attempts to simultaneously deter China from invading Taiwan and Taiwan from declaring independence. This creates a powerful sense of contradiction within Taiwan's defense establishment in both that Taiwan needs to fight against a Chinese invasion independently and that regardless of what Taiwan does, the fate of Taiwan might still be decided in Washington, DC.

1 Taiwan does have, for example, joint-military exercise with Singaporean military (Ani, "Taiwan, Singapore resume military cooperation after long hiatus"), but most of these single-case exceptions are also nestled under the umbrella of a US-led alliance response to any potential Taiwan contingency.

2.2 The Overall Defense Concept and Asymmetric Defense

Facing such uncertainty in allied support, along with decades of force reduction following Taiwan's democratization and a lull in Cross-Strait tension in the late 90s, led to a military plagued by low morale as well as low investment. This situation is further exacerbated by the increasing shift of military balance across the Taiwan Strait, with the People's Liberation Army launching its largest-ever comprehensive reform in 2015. As the operational approach against enemy forces enshrined within the country's biannual National Defense Review gradually shifted from destroying invading forces outside of Taiwan's borders to ensuring their destruction on the beach, the country gradually came to terms with the imbalance and attempted to exploit various strategic and operational asymmetries to its advantage, culminating in the Overall Defense Concept (ODC) (Lee et al. 2020), best characterized with the slogan "a large number of small but lethal things."

Yet the disconnect between the civilian government and defense establishment, an authoritarian legacy, still remains, with the directives issued by the political institutions often failing to translate into operational or tactical realities. Instead, the official capstone documents such as the National Defense Review (NDR) and the Quadrennial Defense Review (QDR) merely serve to pay lip service to the concept promulgated by the civilian government. An example of this can be gleaned from the 2023 QDR, where strategic goals were logically placed, with the preservation of the democratic system and ideal placed Above the preservation of life and property. However, when it comes to the operational level discussion concerning the Overall Defense Concept, traditional exquisite platforms from capital ships to fighter jets were somehow characterized as fulfilling the asymmetric mandate without much explanation.

The convergence of these factors creates powerful incentives to search for a miracle solution from the latest trends in defense circles to solve Taiwan's defense woes. In this regard, the utilization of AI in the defense context is only the latest in a series that also involves autonomous drones and satellite communications. However, the aforementioned force reduction was only the symptom of another societal issue,[2] as Taiwan's birth rate gradually declined over the decade, reaching its nadir in 2023 as the country with the lowest projected birth rate in the world at 1.09 children per woman.[3] For many in the defense establishment, adaptation of defense AI also represented an opportunity to ameliorate some of the pressures brought upon the

2 Force reduction in recent decades, and even the trend toward ending conscription beginning in 2008, was sometimes justified by authorities in claiming that the force structure was unsustainable given Taiwan's low birthrate.
3 "台灣全球倒數第一無解的難題."

existing force structure by the low rate of birth.[4] Chief among them was the proponent of Taiwan's Intelligent Defense Program, General Li Ting-sheng.[5]

2.3 Defense AI Under the Taiwan Context: Do It Cheaper and Do It Faster

Perhaps the most prominent public-facing conceptualization of Taiwan's defense AI is nested within the larger context of the "Intelligent National Defense Program," which began in 2019. Then Deputy Chief of General Staff General Li Ting-sheng, a proponent of the approach, would later disclose that the 10-year program was divided into six sequential stages:[6]

- integration of various technologies with AI;
- integration of Internet of Things (IoT) and 5G technologies with Taiwan's unique strength in Information & communication technologies (ICT);
- support the use of AI-integrated IoT with big data;
- battlefield situational awareness;
- intelligent decision-making;
- cyberwarfare.

The National Chungshan Institute of Science and Technology (NCSIST), the top state-run defense research institution, also set up a parallel "Ten Year Intelligent Defense Plan" aimed at making the intelligent National Defense program a reality. Details of NCSIST's plan were never made public. However, anecdotal evidence suggests that these developments match closely with the Ministry of National Defense's vision of a six-phased approach; orchestrated by the information and communication research division, the plan was to include potential forays into at least two specific use cases: underwater surveillance system that incorporates artificial intelligence to achieve autonomous sensing, learning, identification to for long range ASW early warning and surveillance, and intelligent remote guidance and control to enable autonomous UAV and potentially unmanned teaming through the Artificial Intelligence of Things (AIoT).[7] The essence of Intelligent National Defense, as then director of NCSIST's information and communication research center Lin Gao-chau stated, is the collection, integration, fusion and comparison of data to predict future situations, assist commander's decision making.[8]

4 陳建源, "「人工智慧ＡＩ」無人艦艇軍事倫理問題初探," p. 23.
5 張延廷, "國軍訓練 AI可代勞."
6 賴品瑀, "整合科技研發與作戰運用 智慧國防十年計畫促臺灣成世界核心."
7 涂鉅旻, "中科院推智慧國防10年計畫."
8 涂鉅旻, "中科院推智慧國防10年計畫."

The program launch coincides with the Ministry of National Defense (MND) framing 2019 as the "Year Zero" for Taiwan's intelligent defense, mirroring the "AI Year Zero" on the civilian side by the then Ministry of Science and Technology.[9] This highlighted the MND's desire to take advantage of Taiwan's robust tech ecosystem.

Many of these described efforts demonstrate three things concerning the Ministry of National Defense's approach toward defense AI:

- a propensity to favor the kinetic over the digital;
- a conceptual origin mixed and tackled in the context of digitization and the reactionary threats posed by such, e.g., the penetration of digitized network by PLA cyber actors;
- and as a consequence of the first two, a very limited conceptualization of AI application, with most applications filed under ICT and Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR) contexts.

It is worth noting that the development and standing up of Taiwan's Information Communication Electronic Force (ICEF), colloquially known as the Cyber Force, also suffered a similar identity crisis.

2.4 Regulating Defense AI

While the issue of establishing ethics concerning the use of AI in conflict was raised in the Navy's professional journal as early as 2018,[10] as of the end of 2023, no specific code of ethics governing the use of defense AI exists in Taiwan. The development of defense AI, as all AI development, would have to observe the AI Technology R&D Guidelines issued by the Ministry of Science and Technology (later National Science Technology Council, NSTC) in 2019.[11] The Guidelines stem from three core values the ministry has identified as conforming to universal expectations on the use of AI in the global community:

- Human-centric Values
- Sustainable Development
- Diversity and Inclusion

9 朱泓任, "臺灣AI元年 科技部5年160億打造AI新生."
10 陳建源, "「人工智慧ＡＩ」無人艦艇軍事倫理問題初探."
11 科技部, "人工智慧科研發展指引."

These three core values are further expanded into eight guidelines concerning the research and development of AI:

- Common Good and Well-being
- Fairness and Non-discrimination
- Autonomy and Control
- Safety
- Privacy and Data Governance
- Transparency and Traceability
- Explainability
- Accountability and Communication

Ethics governing specific aspects of AI application also exist and even predate the R&D guideline discussed above: the 2018 Unmanned Vehicles Technology Innovative Experimentation Act,[12] where elements such as the protection of privacy and personal information, ensuring the safety of human beings, and the transparency of AI, are all present in one way or another.

The advent of generative AI also spurred the Executive Yuan, representing the executive branch of Taiwan's government, to issue guidance on its use within constituent ministries and agencies, which include the Ministry of National Defense. The Draft Reference Guidelines for the Use of Generative AI for Executive Yuan and Constituent Agencies issued in 2023 follow many of the values and guidelines of previous documents but explicitly forbid the use of generative AI in the preparation of classified documents or the disclosure and inquiry toward generative AI on issues of a classified nature or concerning personal information. However, a closed-sourced generative AI model deployed onsite can be used in accordance with classification levels. The Guidelines are also expected to be amended on a rolling basis by the National Science and Technology Council (NSTC).[13]

Taiwan's comprehensive answer to the question of ethics governing AI, the Artificial Intelligence Fundamental Act, is expected to be introduced sometime in 2024. The overall regulatory approach will be similar to that of the European Union, through amending specific regulations such as the Personal Data Protection Act. The Fundamental Act itself will classify AI systems into various levels of risk and allow individual competent agencies to come up with specific regulations, such as the Financial Security Commission for regulating intelligence finance, and the Ministry of Transportation will draft detailed codes governing intelligent transportation.[14]

12 Ministry of Economic Affairs, "Unmanned Vehicles Technology Innovation Experimentation Act."
13 行政院教育科學文化處, "行政院及所屬機關(構)使用生成式AI參考指引."
14 王儷華 2023, "防止人類生存被威脅台灣將推AI基本法，會如何監管？"

2.5 Defense AI According to Taiwan's Defense Documents

While exact details of the 10-year AI plan were never publicly disclosed, parts of the vision can be gleaned from other official documents published by the MND. Taiwan's primary external-facing capstone defense documents comprise the biannual National Defense Review (NDR) and the Quadrennial Defense Review (QDR). Under the general direction of building an asymmetric force largely following the ODC, 2021's releases represented the first prominent mention of defense AI as an integrated component of Taiwan's defense concept. The 2021 NDR identified several technologies that have implications for warfighting, as well as influencing the modalities of war. Chief among them is AI, with specific mentions on the development of disruptive AI such as swarm and human-machine cooperative UAVs in the context of the US Third Offset Strategy, as well as the PRC's current focus on AI applications in unmanned systems.

Other disruptive technologies listed include precision strike, wargaming, modeling and simulation, and deepfake.[15] Judging that these would significantly improve the PLA's joint operational capability and pose a significant threat to the Taiwan Strait and surrounding areas, the 2021 QDR stresses the need to integrate these technological trends of information and AI technologies into the development of Taiwan's C4ISR. Specifically, it aims to integrate them into intelligent command and control (C2) systems in order to achieve two major objectives: first, improving situational awareness for the battlefield commander, and second, providing battlefield assessment and decision-making aid.[16] Additionally, the QDR also emphasized developing AI applications in prosecuting offensive and defensive computer network operations (CNO).

The following 2022 NDR, 2022 QDR, and the 2023 NDR all presented similar characterizations for the future direction of Taiwan's armed forces as a combination of the asymmetric approach with the implementation of defense AI: "Mobile, small, man-portable & AI integrated." This is further reflected in Taiwan's latest Five-Year Force Planning Document submitted for review by the parliament in 2023,[17] which echoed the characterization by stating that the aim is to develop a military that conforms to the asymmetric approach to defense as outlined in the ODC. Therefore, force planning should be geared towards improving the military's capacity to utilize and take advantage of "Long-range [fire], Precision [fire], Unmanned [systems], and AI [systems]."

15 Ministry of National Defense, Quadrennial Defense Review.
16 Ministry of National Defense, Quadrennial Defense Review.
17 陳鈺馥 2023, "國軍運用AI 發展不對稱戰力."

Curiously, in the discussion for another major pillar of defense strategy as outlined in the 2021 QDR, that of establishing a self-sufficient defense industrial base (**國防自主**), AI was not identified as one of the major categories to be developed in accordance with the need for defensive combat operations, but instead, only a cursory mention for the development of next-generation intelligent unmanned aerial and underwater vehicles was present (Ministry of National Defense 2021). This is in stark contrast to the positions taken by the government during the 2017 establishment of the then-brand-new ICEF, where one of the three major directives for the new branch issued by President Tsai was to pioneer the development of an academic and industrial base for Taiwan's cybersecurity scene.[18]

2.6 Origin of the Defense AI Civil-Military Ecosystem

On the civilian side, Taiwan launched the "Taiwan AI Action Plan" by the Ministry of Science and Technology to push for the establishment of a civilian AI development ecosystem that attempts to leverage Taiwan's unique position in the global semiconductor supply chain.[19] The origin of the parallel civilian and defense technology development ecosystem can at least be traced back to the National Science and Technology Development Plan for 2013-2016.[20] Since then, one of the primary missions of the self-sufficient defense industry has been to spearhead technology and industry development, acting as the driving force for industry. This was further cemented in 2020 during President Tsai's speech, in which the government has centered a civil-military integrated defense industry as one of the country's six major core strategic industries.[21] The details of such plans are further laid out in the Defense Technology Development Blueprint and White Paper, which also encompasses the plans to set up defense research centers within university campuses[22] and the creation of the Defense Advanced Technology Development Program.[23]

18 楊孟臻 2017, "資通電軍指揮部成立　蔡英文交付3項任務."
19 行政院, "台灣AI行動計畫—掌握契機，全面啟動產業AI化."
20 行政院國家科學委員會, "國家科學技術發展計畫 (民國 102 年至 105 年)."
21 National Development Council, "六大核心戰略產業推動方案."
22 Ministry of Science and Technology, "科技部徵求110年「學研中心」專案計畫."
23 國防部軍備局, "112年「國防先進科技研究計畫」構想書."

3 Organizing Defense AI

There is no dedicated defense AI organization, from policy to research to production and employment, within Taiwan's defense innovation ecosystem. Instead, various directives and experimental programs are nestled within different tiers of Taiwan's Defense Technology Development Mechanism (DTDM), with the majority of disclosed research programs belonging to the Defense S&T Research Center initiatives located in various universities.

3.1 The Defense Technology Development Mechanism

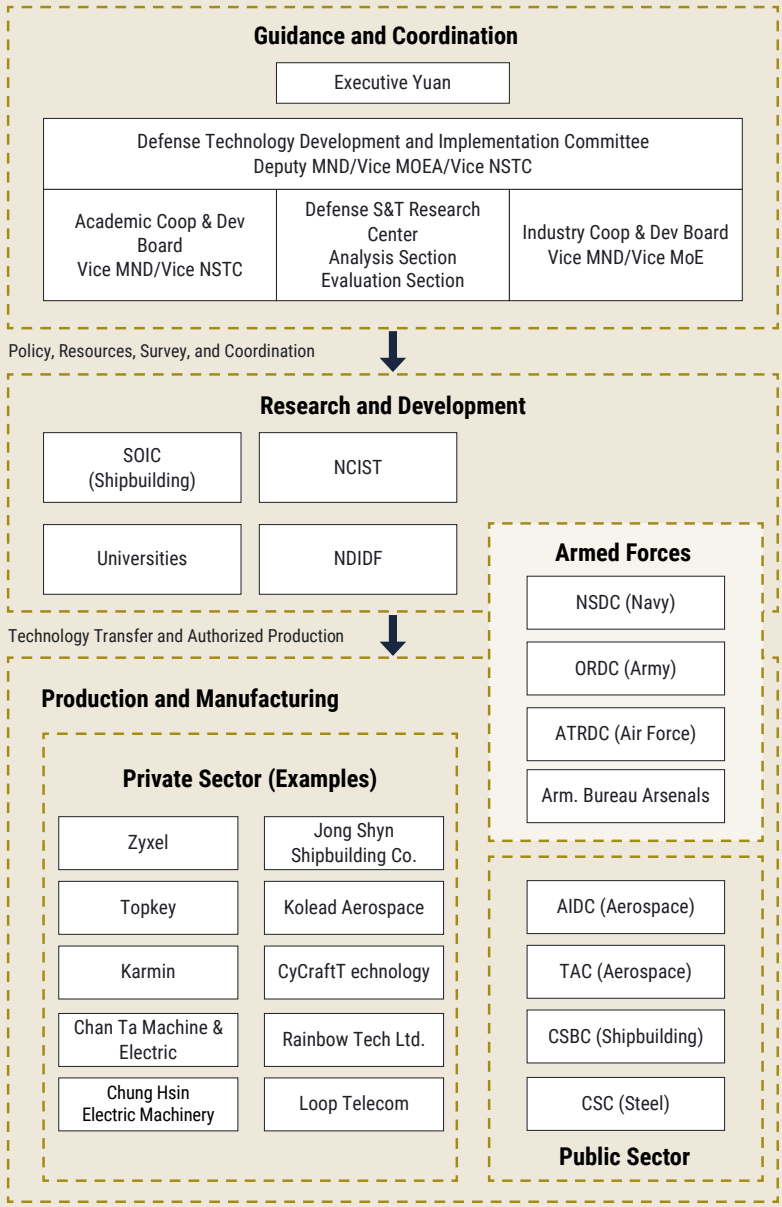
The DTDM can be roughly separated into three tiers (Figure 1): policy guidance and coordination, research and development, and production and manufacture. At the top is the Defense Technology Development and Implementation Committee, chaired by the Deputy Minister of Defense, the Vice Minister of Economic Affairs, and the Vice Chair of the National Science and Technology Council, along with 25 members consisting of experts from the public and private sectors. The committee coordinates a slew of government organizations and provides policy guidance for the research and development tier of the system.[24]

The research and development tier of the DTDM spans both the public and private sectors. A series of armed forces organizations, including the Navy's Naval Ship Development Center (NSDC), the Army's Ordnance Readiness Development Center (ORDC), the Air Force's Aerospace Technology Research and Development Center (ATRDC), and the Armaments Bureau's various arsenals occupy both the R&D tier as well as the production and manufacturing tier, as they sometimes take part in limited production for more specialized projects, either due to sensitivity or lacking economy of scale for serial production at a larger venue.

Outside the armed forces, the National Chungshan Institute of Science and Technology (NCSIST) leads research and development on sensitive defense projects. The most sensitive projects, or parts of the projects that require security clearance unavailable to civilian institutions, are exclusively conducted within the confines of the defense industry development institutions (**國防工業發展機構**),[25] directly under the auspices of the MND. This means that, with few exceptions, most publicized research projects are restricted to equal or below technology readiness level (TRL) 5.[26]

24 林柏州, "「智慧國防計畫」與國防科技機制發展."
25 The term is used opposite of the "academic research institutions" that characterized the centers under various universities. However, the exact definition of which agencies are included as part of the national defense industry development institution were never explicitly stated in official documents. Nevertheless, the term has made multiple appearances in various policy documents, including a concept note by the MND's Department of Integrated Assessment describing research programs open for bids.
26 Personal interviews with relevant personnel indicate that this is the cut-off point.

Figure 1: Taiwan's Defense Technology Development Mechanism



Abbreviations: AIDC Aerospace Industry Development Cooperation; ATRDC Aerospace Technology Research and Development Center; CSBC China Shipbuilding Corporation; CSC China Steel Corporation; MND Ministry of National Defense; MOAE: Ministry of Economic Affairs; NCIST National Chungshan Institute of Science and Technology; NDIDF National Defense Industry Development Foundation; SOIC Ship and Ocean Industries R&D Center, TAC Taiwan Aerospace Corporation

Source: Translated from https://indsr.org.tw/respublicationcon?uid=12&resid=729&pid=2868 (last accessed 22 February 2024).

The Ship and Ocean Industries R&D Center (SOIC)[27] and the National Defense Industry Development Foundation (NDIDF)[28] serve their respective niches as ship-building R&D centers and legacy funds for defense investment and tech transfers. Universities took center stage as the most vibrant part concerning defense AI in the DTDM. The details and projects involved under the various universities' Defense Technology Research Centers will be further elaborated and examined in the next section.

For production and manufacturing, most prominent projects are still produced through public sector companies such as the Aerospace Industry Development Corporation (AIDC), Taiwan Aerospace Corporation (TAC), China Shipbuilding Corporation (CSBS), and China Steel Corporation (CSC), with vibrant participation on manufacturing of subsystems and miscellaneous components from domestic private sector companies such as Zyxel, Chan Ta Machinery & Electric and Chung Hsin Electric Machinery Manufacturing Corp.

3.2 Defense S&T Research Center and Corresponding Universities

The most active and public portion of the DTDM concerns the "academic research center (**學研中心**)" initiative. A joint venture between the Ministry of Science and Technology and the Ministry of National Defense started in 2020, the NTD5bn (USD167M) initiative aimed to establish an initial three to six research centers in various universities in order to foster systematic and continuous research on defense applications for various technologies. The initial focus of the project consists of seven major areas of research:

- technology foresight research on sensing and precision manufacture;
- advanced materials and analytical mechanics;
- information, communication, electronics, and smart technologies;
- critical systems analysis and integration;
- cutting-edge power plants and aerial vehicles;
- advanced surface vessels and underwater vehicles;
- advanced systems engineering research.

27 For more information, see: https://www.soic.org.tw/ (last accessed 22 February 2024).
28 For more information, see: https://www.ndidf.org.tw/ (last accessed 22 February 2024).

These research centers also serve as think tanks for defense technology development, advising on various topics, including the defense application of artificial intelligence for the Ministry of National Defense.[29]

By 2023, there were at least seven defense S&T research centers located in various universities around Taiwan,[30] each specializing in one of the seven areas of focus (Table 1). These research centers are coordinated through the Defense S&T Research Center under the competence of the Defense Technology Development Implementation Committee (Figure 1) located under the National Defense University's Chung Cheng Institute of Technology (CCIT).

Table 1: University Defense S&T Research Centers and Specializations in Taiwan

Universities	Specialization	Research Center
National Taiwan University (臺灣大學)	Technology foresight research on sensing and precision manufacture (前瞻感測與精密製造研究)	National Defense Technology Academic Research Center (國防科技學研中心)
National Tsinghua University(清華大學)	Advanced materials and analytical mechanics (先進材料與力學分析研究)	National Defense Technology Academic Research Center (國防科技學研中心)
National Yang Ming Chiao Tung University (陽明交通大學)	ICE & intelligent technologies (資電通訊與智慧化科技)	Technology Foresight and Systems Academic Research Center (前瞻科技與系統學術研究中心)
National Chung Hsing University (中興大學)	Critical system analysis and integration (關鍵系統分析與整合)	National Defense Critical Systems Research and Development Center (國防關鍵系統研究發展中心)
National Cheng Kung University (成功大學)	Cutting-edge power plants and aerial vehicles (尖端動力系統與飛行載具)	Wang Tsoo Systems Engineering Research Center (王助系統工程研究中心)
National Sun Yat-sen University (中山大學)	Advanced surface vessels and underwater vehicles (先進船艦及水下載具)	Academia Research Center of Underwater Vehicles (智慧操控水下載具學研中心)
National Defense University (國防大學)	Advanced systems engineering research (先進系統工程研究)	Advanced Systems Engineering Research Center (先進系統工程研究學研中心)

Sources: 國立台灣大學 2021; 清華大學 2021; 陽明交通大學 2021; 中興大學 2021; 成功大學 2022; 中山大學 2021; 中山新聞 2021; 蘇恩民 2023

29 張玲玲, "科技結合創新 建構智慧國防."
30 科技部, "111 年度科技部「國防科技探索專案計畫」徵求公告."

3.3 Defense Technology Research Programs for Academia

There are two major defense technology research programs with three distinct horizons for maturity under Taiwan's defense innovations ecosystem: the Defense Technology Exploration Program (**國防科技探索專案計畫**, DTEP), which focuses on projects with long maturity timeline;[31] and the Defense Advanced Technology Development Program (**國防先進科技研究計畫**, DATDP), which fund projects with maturity horizons either in 3 years or 5-8 years depending on the category.[32]

While these programs seemed to be tailor-made for defense S&T research centers coordinated through NDU CCIT's Defense S&T Research Center, application and participation in these research programs are not limited to the seven centers but are open to general academic institutions as well.

Defense Technology Exploration Program (DTEP)

DTEP, orchestrated by the Ministry of Science and Technology/NSTC,[33] is patterned after the Artificial Intelligence Exploration (AIE) and Microsystems Exploration (μE) programs conducted by the US Defense Advanced Research Projects Agency (DARPA). The DTEP aims to focus on dual-use technologies concerning small to medium unmanned vehicles in the air, ground, surface, and underwater terrains, as well as information, communication, electronics (ICE), and cybersecurity technologies.[34] The program invites submissions based on an envisioned scenario and uses a case in the 10-30-year horizon. Proposed projects will be evaluated first on the scenario set before technical evaluation. Successful pitches are given 18 months and a maximum of NTD8M (USD26,6700) per year to develop a proof of concept or a prototype, with the end results evaluated and rolled into consideration for approving future pitches by the same investigator.[35]

Unfortunately, the list of approved projects under the DTEP is unavailable to the public. While DTEP has a stated goal of encouraging innovative thinking on future scenarios regarding defense technology application, the request for the proposal listed extremely detailed guidelines taken directly from the year's National Defense Review (NDR) on Taiwan's current operational threat environment and current defense tactical needs. While this no doubt provides comfort for applicants to neatly categorize their proposals under the current understanding of the opera-

31 科技部 2022.
32 蘇思云 2020.
33 MoST reorganized as NSTC in 2022.
34 科技部 2022.
35 科技部工程司, "國防科技探索專案公告說明會."

tional environment, this somewhat defeats the purpose of an exploratory program with a long-term horizon and, to a certain extent, also explains the limited and scattered nature of the project requirements been issued by different stakeholders within the defense innovation ecosystem.

Defense Advance Technology Research Program (DATRP)

DATRP, orchestrated under the Ministry of National Defense, covers a wide range of topics, where individual organizations under the ministry submit concept notes outlining interested projects and the timeframe of execution for academic institutions to apply. Generally, new projects are unveiled every year and can be divided into two categories: foundational research, with a maximum timeframe of three years, and breakthrough research, with a maximum timeframe of up to eight years. The submitted projects follow the seven focus areas outlined for the academic research centers (Table 2). However, the agencies vary and include many organizations, from Navy HQ, Air Force HQ, and ICEF HQ to MND's Department of Integrated Assessment and more. Some projects even originated from within DTDM's research and development tier, such as NCSIST and the Navy's NSDC, and even various arsenals under the Armaments Bureau. The number of projects submitted every year is also quite large. For 2023 alone, there were over 140 approved projects of varying sizes and lengths.[36]

36 國防部, "國防部 112 年「國防先進科技研究計畫」評鑑實施計畫."

4 Developing Defense AI

This section will examine a selection of projects under the Defense Advance Technology Research Program (DATRP) from FY2022 and FY2023 involving the use of defense AI. Evaluation of technological maturity conforms to the technology readiness level (TRL) system first developed by NASA.[37] Most projects were aimed at raising the underlying application's TRL to 4 or 5 for further development and included detailed definitions of specific technology readiness levels as appropriate for the application. Given the strategic role of the Air Force, we start with a more in-depth discussion of an Air Force AI project, followed by a brief overview of additional projects.

4.1 Developing Artificial Intelligence Applications for Close-Quarter Air Combat

The Air Force has always been Taiwan's first line of defense against a Chinese invasion, and it has traditionally enjoyed political favoritism since the time of Chiang Kai-shek.[38] Thus, the attempt of the Air Force Technology Research Development Center (ATRDC) to develop an AI pilot within a simulated environment[39] deserves special mention as this project is unique so far as it is technically ambitious, organizationally far-reaching, yet conceptually ill-formed.

Inspired by DARPA's AlphaDogfight project, the goal of the three-year project is threefold. First, to develop an intelligent platform capable of simulating operational scenarios involving an AI pilot for tactics development and validation. Secondly, develop an AI pilot that optimizes decision-making based on different scenarios, environments, and mission objectives. Thirdly, develop metrics for evaluating AI pilots' performance and feasibility for different missions.

Most of the technical challenges for the project have been assessed to be a development from TRL 3 to 4, such as underlying technology required to simulate the battlefield and vehicles, basic architecture for multi-ship engagement, and integration of control interfaces for algorithms representing different fighter aircraft. A few challenges were judged to be more significant leaps, such as adapting machine learning algorithms from rule-based, supervised to reinforcement learning to the specific use case of within-visual-range (WVR) air combat. The development was judged to be a jump from TRL 2 to 5, with medium risks. Developing an AI agent

37 國防部, "國防部 112 年「國防先進科技研究計畫」評鑑實施計畫."
38 許劍虹," 許劍虹觀點：重空軍而輕海軍的蔣中正."
39 國防部軍備局, "112年「國防先進科技研究計畫」構想書."

(pilot) capable of conducting basic flight maneuvers within the simulated environment was also categorized as a jump from TRL 2 to 4, with medium risks.

Conceptually, similar to many Taiwan armed forces projects, its stated origin is to follow the "trend set by major military powers," achieving a vision of "mosaic warfare" as set out by DARPA, where distributed shooters and sensors allowed the massing of firepower without having to mass forces.[40] The idea is to increase complexity for adversary engagement through a limited increase in friendly platform numbers and vastly improved adaptability (and thus resiliency against attrition) on how these platforms can work together. Upon closer examination of the ATRDC's project proposal language, however, it is uncertain whether the Air Force had sufficiently considered its adaptation under Taiwan's operational context. In describing the future concept of operation, the proposal stated that the system should be able to achieve the following:

> In a simulated environment, validate [the feasibility of] UAV wingman and manned lead aircraft can conduct missions together, that the human pilot can communicate and control the AI pilot to execute its assigned mission, with order relayed through datalinks to the UAV wingman, where UAV wingman can achieve a high degree of autonomy through developed algorithm, and complete the mission assigned by the human lead, thus enhancing the Air Force's capability to conduct manned/unmanned operations.[41]

This is almost an exact copy of the US Loyal Wingman project's conception of operation, aimed at operating against a near-peer power under a contested environment facing complex integrated air defense systems (IADS).[42] However, the often-unstated assumption here is that this is used offensively during the first days of a future war to conduct either deep penetration or suppression or destruction of enemy air defense (SEAD/DEAD) operations into enemy territory.

This is, however, far from the operational environment facing the Taiwan Air Force (TAF). The role of TAF is defensive, with contesting control of the air as its primary mission.[43] A mission Loyal Wingman would be ill-suited for since it is principally developed, at least currently, for air-to-ground operations.[44] Furthermore, the extremely limited airspace above Taiwan is already heavily monitored, with the second highest density in radar stations and air defense missiles in the world,[45] controlled through four Regional Operation Control Centers (ROCCs), each capa-

40 "DARPA tiles together a vision of mosaic warfare."
41 國防部軍備局, "112年「國防先進科技研究計畫」構想書."
42 Losey, "How autonomous wingmen will help fighter pilots in the next war."
43 中華民國空軍, "空軍任務."
44 Fish, "Uncrewed ambitions for the Loyal Wingman."
45 朱明," 提升空軍防空飛彈攔截效能　「寰網」聯戰採以色列系統作為主要核心技術."

ble of independently directing air defense of the entire island.[46] The surveillance network is further augmented by airborne E-2T AWACS. This comprehensive air defense network calls into question the utility of a loyal wingman-like platform to act as an independent sensor platform. Furthermore, in the absence of aerial refueling assets, all airborne assets suffer similar restrictions regarding time on station, and the limitation of operating from airbases under constant threat due to proximity to Chinese missiles, rockets, and artillery, further reducing the advantage offered by such approach.

It is also interesting to examine the project's focus on WVR engagements, an understandable focus given the limited airspace above the Taiwan Strait and the relative proximity between Chinese and Taiwan airbases. Any beyond visual range (BVR) engagement would very quickly devolve into a dogfight, and most engagements would offer little chance for coordinated and organized flow that a more offensively postured air force such as the US Air Force would be accustomed to.[47]

Considering the defensive posture, and air-to-air mission focus of the force, another concept of operations (CONOP) in the proposal entitled "maximizing UAV package recon/attack range" is even more puzzling:

> In a simulated environment, when a UAV package is conducting recon/attack missions, it can utilize the minimum number of UAVs in achieving maximum effect. And although the goal is to minimize the number of UAVs engaged, redundancy should still be considered; beware of the tradeoff between reliability and UAV numbers to maximize operational range.[48]

It is hard to conceive that – under the current strategic guidance and operational doctrine –such an eventuality would manifest itself as a cost-effective measure for Taiwan's armed forces. And while Taiwan's newly affirmed ODC based on exploitation of operational and tactical asymmetry, with its heavy emphasis on ground-based air defenses over organic fighter components, does not completely deny the value of fighter jets for its primary mission of air defense. It is perhaps worth further careful examination as to what asymmetric advantage such an unmanned, AI-agent-based UCAV could actually offer under Taiwan's strategic and operational context, especially considering the significant technical and organizational challenges to overcome.

A second category of issues stemmed from the ambitiousness of the program in overcoming technical challenges in an impossibly short timeframe. Not only does

46 徐葳倫 et al., "71年首次 空軍作戰指揮部"封洞"清消."
47 In an interview, a former USMC pilot shared his experience training an air force with limited airspace, playtime and a purely defensive concept of operation. https://www.youtube.com/watch?v=2sSOXVGGz4k (last accessed 22 February 2024).
48 國防部軍備局, "112年「國防先進科技研究計畫」構想書."

the project attempt to replicate the results of Heron's winning bid for DAPRA's AlphaDogfight challenge (Tucker 2020), it further seeks to develop and implement human-machine teaming (HMT), which currently lacks any reliable framework for testing, evaluation, validation, and verification (TEV&V) (Motley 2022) within a yet to be developed simulated environment. The project further sought to involve not only academic research centers but also the defense industry development institutions, ATRDC, and active-duty pilots. All these efforts are to be accomplished, as defined by advancing development to TRL 5, within a mere three years.

Given the conceptual ambiguity and technical challenges facing such an effort, it is uncertain whether this particular effort represents an exploitation of Taiwan's asymmetric advantage in defense AI.

It is worth noting the possibility that the Air Force undertook this project with an eye on future acquisitions of collaborative unmanned combat systems from the United States. Over the course of the long history of US-Taiwan Foreign Military Sales after the end of Taiwan's official diplomatic ties with the US in 1979, there has long been an unspoken tradition that it would be easier for Taiwan to acquire the technology or weapon system it sought should a domestic example be developed first. A prominent example of this approach was the development of Taiwan's indigenous defense fighter, the F-CK-1, where the successful development of the jet was quickly followed by the approval of sale for 150 F-16 A/B Block 20 by the Bush administration after decades of consistent denial.[49] Should this be part of the consideration in the Air Force's decision to pursue this ambitious project, a retrospective approach, examining Taiwan's advantage in data collection concerning the Chinese threat, may open doors for such possibilities. This is particularly true as US forces, especially the US Air Force, have also been pushing for a "YESFORN" approach in the operational realm. This is in opposition to the traditional NOFORN classification, where even close foreign partner nations would not be allowed access. The approach was championed specifically to ameliorate data acquisition for developing AI agents in the operational realm, and thus, Taiwan's possession of valuable operational data may prove to be the right incentive at play.

49 楊俊斌, "逼美方加速出售F-35 台灣自行研發新戰機."

4.2 Additional Defense AI Projects

In addition to ATRDC's development efforts, Taiwan has also launched additional defense AI projects for support tasks, to advance predictive maintenance, for IT network management, and to assist space-based assets:[50]

- **Optimizing Air Defense Launchers and Supporting Mechanisms with Artificial Intelligence (運用 AI 智慧技術優化防空裝備發射暨支撐機構系統開發)**
  Issued by the Army's Missile and Electro-Optics Depot for FY2022-2023, budgeted at USD1.5M, the project aimed to develop a series of autonomous stabilization and preventative maintenance systems using AI. Significant technical challenges were projected for creating the intelligent diagnostic system for motors, bearings, and thread rod loads, the digitized monitoring system for the support struts motivator, and the intelligent monitoring system for the missile's box launcher motivator. All developments were judged to be a leap from TRL 1 to 4, as most of the prerequisite digitization to allow AI adaptations on machinery were non-existent.

- **Intelligent Balancing and Calibration of Vessel Propeller Shaft(艦艇動力旋轉機構智動平衡校正之研究)**
  A project issued by Navy Headquarters for FY2022-2024, budgeted at USD100,000 for the first year. The project sought to utilize AI in the total life cycle management of a naval vessel's main screw(s), to facilitate preventative maintenance to increase mean time between repairs (MTTR) and estimate spare parts requirements. The project is divided into two major capstones: first, design a simulation of vessel propulsion system referencing MIL-STD-2189 (design methods for naval shipboard systems), validate with real-world data, and conduct dynamic analysis. Secondly, the project will develop a monitoring mechanism for the propulsion system's vibrations. This would allow real-time monitoring of the fatigue developed through normal wear and tear and enable automatic stabilization when unexpected vibrations occur.

- **Introduction of AI for System Failure Predictive Analysis in Aerial Vehicle Automated Monitoring System (航空載具自動化監控系統與導入人工智慧進行故障預判之研究與分析)**
  Issued by Air Force Headquarters for FY2022-2024, budgeted at USD40,000 for the first year. This is intended as a lead-in project to prepare the service for the introduction of AI analytical tools (such as for maintenance and repair).

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50 Based on 陸軍飛彈光電基地勤務廠," 運用 AI 智慧技術優化防空裝備發射暨支撐機構系統開發. 陸軍飛彈光電基地勤務廠," and 國防部, "國防部111年「國防先進科技研究計畫」申請書徵求主題一覽表(突破式國防科技研發計畫)."

The project will survey and identify appropriate data required and automated monitoring mechanisms necessary for the service's aerial vehicles. Particular attention will be paid to the data transfer methods, which must be in compliance with regulations preventing interference with airborne equipment and communications.

- **AI Trained SDN Network Orchestration for Network Management and Security Detection (以人工智慧導入SDN網路編排管理與安全檢測之研究)**
  Issued by the ICEF Headquarters for FY2021-2023, the project intends to utilize an AI algorithm to design a software-defined networking (SDN) architecture for Taiwan's armed forces and reorient the armed forces' various networked modules and platforms under this newly established architecture. The project is divided into three year-long phases with three respective capstones: establishing a network detection platform to analyze behaviors of individual packets and collecting information on SDN network and services for the first year, budgeted at USD60,000. The second year is spent on establishing an appropriate AI training and detection model to develop network orchestration techniques suitable for Taiwan's armed forces, budgeted at USD83,333. These efforts would culminate in the integration and evaluation of the Armed Forces' various platforms and modules subsumed under an SDN architecture in the final project year, with an additional budget of USD83,333.

- **Satellite Image Information Platform Development: Adaptive Semi-supervised Deep Learning Architecture (衛星圖資分析平台開發：具可適性之半監督式深度學習架構設計)**
  Issued by Arsenal 401 for FY2020 to 2022, budgeted at USD40,000 for its final year, the project aims to provide the basis for a common operational picture (COP) and utilize semi-supervised deep learning in the analysis and prediction of changing geological and terrain features, river, and maritime anomalies.

- **AI-Assisted Next Generation Satellite Point Cloud Matching and Object-Oriented 3D Model Construction From Satellite images (AI輔助新世代衛星點雲密匹配及物件導向三維建模研究以衛星影像為例)**
  This is a follow-up to the previous project establishing AI-mapped terrain for a COP issued by Arsenal 401 for FY 2022-2024. Budgeted at USD66,666 for the first year, the project aims to construct ultra-high-resolution 3D object-oriented satellite images from vector models. Using clustering techniques and AI/ML algorithms on existing point clouds produced from satellite remote sensing, a vector model can be identified as an object, such as a building. Sufficient mapping of these objects can then allow the detection and prediction of changing geological and terrain features, such as river and marine abnormalities.

4.3 Discussion

Additional defense AI research projects vary, from using AI to optimize UAV flight paths to identify and map dangerous obstructions around airfields to intelligent target identification for night-time urban warfare and intelligent algorithms for tactical simulators. However, with the curious exception of the Air Force's AI dogfight project, most of these revolve around niche applications that endeavor to enhance, rather than revolutionize, the way business is done within the Taiwan armed forces.

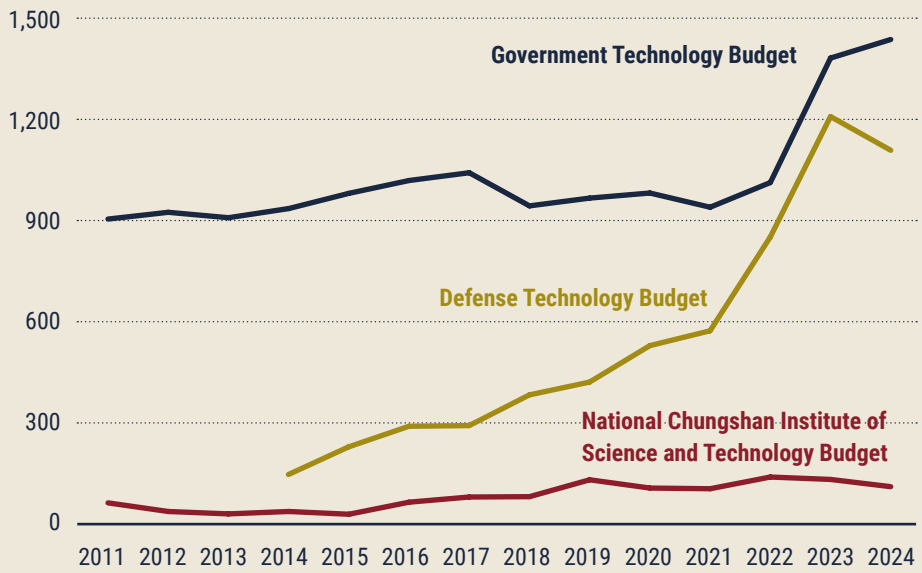
Examination of the DTEP and DATRP series programs reveals that Taiwan's approach to the development of defense AI, and defense technology innovation in general, to be a relatively unfocused effort, and while there seemed to be some doctrinal attempts at narrowing down use-case and scenarios, the basic understanding of defense AI application does not exceed data-based optimization on "how to do things cheaper and faster."

5 Funding Defense AI

No dedicated budget categories for defense AI exist; financial resources for the projects reviewed above came from two sources: the academic research center initiative totaling NTD5bn (USD167M) over the course of five years, establishing seven defense research centers,[51] and the overall defense technology budget (Figure 2).

Taiwan's defense technology budget has steadily increased over the past decade or so, consistent with the government's push to establish a self-sufficient defense industrial base through primarily public sector investment. It is, however, worthwhile to note that, for example, in 2023, such expenditure accounted for around 3.16% of the total defense budget,[52] as compared to the United States, where research, development, test, and evaluation (RDT&E) accounted for about 17% of the total defense budget in the same year (Thomas 2023).

Figure 2: Taiwan Technology Development Budget (in NTD100M)



Source: Total government technology budget and defense technology budget from Taiwan's Directorate-General of Budget, Accounting and Statistics (主計處 Undated).

NCSIST budget from NCSIST website financial disclosure section. (國家中山科學研究院 Undated)

51 蘇思云, " 培育7大領域科研人才 科技部攜手國防部5年砸50億."
52 Taiwan's defense budget for 2023 was NTD415.1bn (國防部 2022).

The annual budget for NCSIST, which conducts most of the application research once these development programs reach a certain level of maturity or sensitivity, has increased significantly over the past few years. While it is tempting to attribute these as pure R&D budget, it is important to note that NCSIST also conducts limited production of indigenous weapon systems. A non-trivial portion of its recent budget increase can be accounted for as part of the 5-year NTD240bn (USD8bn) contract NCSIST signed with the Ministry of National Defense on the indigenous production of eight major weapons systems.[53]

Perhaps another overall metric of Taiwan's public sector tech development financial resources would be to examine the Taiwanese government's overall budget for tech development, which has also experienced significant increases in the past few years as initiatives such as the 5+2 industry innovation and intelligent country initiatives took hold.[54] This brings Taiwan's overall government technology budget as a percentage of GDP in 2023 to an impressive 4.5%,[55] whereas OECD countries average around 2.3-2.4% in this category.[56] After Taiwan's election on 13 January 2024, the incoming Lai administration has indicated their focus on five major categories of industry, which included both AI and defense as two out of the five.[57]

53 范正祥, "落實國防自主政策 中科院預算連續兩年破千億."
54 蘇文彬, "國科會規畫2025年我國科技預算1,800億元，投資晶創台灣、淨零、科研人才、太空科技."
55 Gross GDP of Taiwan in 2022, calculated (行政院主計總處, 2023).
56 https://www.oecd.org/sti/msti.htm (last accessed 22 February 2024).
57 呂雪彗, "因應地緣政治 賴清德主打五大信賴產業."

6 Fielding and Operating Defense AI

While there has been a slew of research projects on defense AI for the past few years, public disclosure of the Armed Forces' operational defense AI applications has been relatively limited. And while the Air Force has expressed interest in exploring the application of AI for combat aircraft predictive maintenance and in the command and control of integrated air defense system (IADS) since the 2019, to date there have not been public disclosures on the status of such developments. A few scattered examples are outlined below to provide a feel of Taiwan's sensitivity in disclosing its defense AI application. Notably, a few of these examples even predate the armed forces' focus on AI starting in 2019. Such as the trend for developing AI-based medical solutions for military logistics can be traced back to the 2017 NDR:[58]

- **Intelligent ECG Analysis Platform**
  An advisory panel on the development of intelligent military medicine was convened in 2019 consisting of members from the MND Medical Affairs Bureau, physicians, and industry representatives, to promote the development of AI application in medical affairs. In cooperation with Quanta Computer, the armed forces established an AI Lab in 2020.[59] The effort seemed to bear some fruit in 2023 with the successful development and tech transfer to Quanta of the AI-based electrocardiogram (ECG) analysis platform, enabling advanced diagnoses of multiple cardiovascular disease, especially for remote areas with few experienced medical personnel present.[60]

- **Constructive Mixed Reality CPR and AED Training System**
  The Hualien Armed Forces General Hospital has developed a mixed reality training system for the instruction and training of cardiopulmonary resuscitation (CPR) techniques and the use of automated external defibrillator (AED). The system employs an AI-generated constructive simulation with a virtual patient and virtual AED, while allowing an on-site instructor and trainee to simultaneously interact with and monitored by the simulation through linked cameras, receiving instantaneous feedback on accuracy of the technique and effects on the patient.[61]

- **AI Performance Trend-based Engine Monitoring and Diagnostic System**
  In 2018 the Air Force Institute of Technology demonstrated to the press corps a predictive engine monitoring and diagnostic system. Based on the digitization of past engine maintenance records and designs for Taiwan's next-generation jet engine for the Air Force's future fighter program, they were able to construct a digital simulation of the engine to predict failure trends. The

58 國防部, " 106年國防報告書," p. 181.
59 國防部, "110年國防報告書," p. 121.
60 范瑜, "國醫、三總攜手廣達 打造心電圖AI判讀平臺."
61 國防部 2021; 陳穎信 et al.,"建構MR心肺復甦術+AED教學系統."

system won gold medal and the special contribution award in Poland's International Innovation Fair.[62]

Curiously, these projects both have clear dual-use implications, with the ECG analysis platform being an interesting example of an application developed by the armed forces that has been adapted for civilian use, a rare occasion in Taiwan's defense industrial complex. But perhaps the most damning testimony on the state of Taiwan armed forces' fielding of defense AI came from the original proponent of the Intelligent National Defense program, General Li Ting-sheng. In an op-ed published in August 2023, General Li, now retired, remarked that the Armed Forces' application of AI to replace manpower in the spirit of asymmetric and innovative approach to defense has largely remained a matter of slogan, and rarely implemented.[63]

62 徐振威, "「故障預判」交給AI！導入航空發動機監控系統保飛安."
63 張延廷, " 國軍訓練 AI可代勞."

7 Training for Defense AI

For the training pipeline feeding into the development ecosystem of defense AI in Taiwan, the NTD5bn academic research center initiative reviewed in previous sections is relevant. On top of establishing defense research centers, the initiative also included provisions for training 150 graduate-level researchers for defense technology research. But for defense AI training, the focus seemed to be the employment of AI for computer network operations (CNO), setting up sections on information systems and network offense and defense under the department of information systems engineering of the National Defense University Chung Cheng Institute of Technology (CCIT) as early as 2016.[64] Education on AI applications for defense logistics was introduced at Navy and Air Force Academies in 2019 largely through one man's effort, former Navy engineer Dr. Wang Zhi-zhong and his company Xwin Prognostics Technology, in collaboration with Microsoft and Axiomtek.[65]

Systematic training on the conceptual employment of AI in the defense realm seemed to be lacking, other than the occasional conferences and workshops, predominantly focused on the intersection between digitization, cyber, and AI, targeting senior-level officers,[66] with occasional forays into issue areas such as the application of AI in AR and VR training,[67] there does not appear to be an overall initiative aimed at providing the force with a comprehensive understanding for the role defense AI may play in future conflicts.

The incorporation of AI into civilian defense education seemed to have received a better hearing on the civil defense education side following the outbreak of the Ukraine war, where middle-school activities on defense AI included simulations of battlefield operations involving autonomous UAVs and ground vehicles.[68]

Incorporation of defense AI into training scenarios for the armed forces also proved promising, specifically in using AI to assist analysis of big data accumulated in training to improve future training modalities. The most prominent example lies in the medical realm, specifically at the National Defense Medical Center. The center has been incorporating augmented reality (AR), mixed reality (MR) and smart glasses in the training of simulated tactical combat casualty care (TCCC), simulated mass casualty event, simulated patient care on med-evac vehicles, and simulated assessment and emergency care for CBRN event. Data collected from these training events were incorporated with questionnaires filled by trainees post-event and analyzed through statistical software such as SPSS before feeding into the database for processing by AI algorithm to improve future training events.[69]

64 國防大學理工學院, "歷史沿革."
65 李恬郁, "國軍後勤AI推手 原來是他！."
66 周昇煒, "國防部邀國網中心辦理AI發展講座 建構專業能量."
67 中華民國陸軍, "人工智慧結合擴增實境的軍事應用專題講演,"
68 方志賢, "推動全民國防教育 AI無人機、無人車納入活動、模擬戰場實況."
69 楊策淳 et al, "國軍戰術戰傷救護模擬訓練之成效分析與鏈結AI人工智慧發展"

Other experimental examples of AI-assisted training methodologies include the National Defense University Management College's Military Human Factors Research Center, which began constructing databases of biometric data during the Marine Corps' long endurance exercise in 2019 and has recently been experimenting with collecting biometric data from soldiers engaged in VR simulations mounted on top of a 6-axis motion control platform for analysis on how to improve future training regimes.[70] Another experimental approach conducted by a doctoral candidate at the National Taichung University of Education to improve military aircraft maintenance training through an AI-chatbot constructed under the messaging app LINE, which is capable of dynamically adjusting training materials based on trainee input, also received statistically significant improvement when compared with traditional training methodologies.[71]

70 蕭佳宜, "管理學院科技教學 深化國軍訓練效能."
71 袁佳慶, "導入人工智慧對話式機器人教學以提升國軍飛機修護訓練成效"

8 Conclusion

Much of Taiwan's approach to defense AI can be analogized as a microcosm of its approach to the defense of the nation, which can be summarized into three observations:

- **Observation 1: A propensity for "things done cheap" instead of "things done differently"**
  A colloquial term often coined to describe Taiwan's current industrial approach is the "cost-down" approach.[72] From many of the projects examined in this chapter, we can see that the approach was not a comprehensive rethinking on how business can be done differently, but how business can be done "cheaply." Such inability for conceptual innovation even extends to the one case examined where the Air Force attempted a more ambitious approach in developing defense AI, but instead resulted in a project riddled with doctrinal contradiction.

- **Observation 2: A defense policy serving two masters – a government disconnected**
  The legacy of an authoritarian government created a rather disjointed approach to defense policy, where higher-level strategic considerations are disconnected with the operational and tactical realities executed by the defense establishment. The contradictory approach to the definition of asymmetric warfare to defend the country is just one example. Another noteworthy example was the six major core strategic industries development plan approved by the President and issued by the National Development Council in 2021,[73] which included three isolated sectors of defense and strategic industries, cybersecurity industries, and information and digital industries. This delineation neglected the MND's 2019 Ten Year Intelligent Defense Initiative that sought to leverage Taiwan's civilian industry capabilities in achieving its six-phased approach that culminated in the ability to conduct AI-enhanced cyberwarfare, instead delineating defense and strategic industries as involving two major categories; aerospace and maritime vessels, and space low earth orbit (LEO) satellites and ground equipment, robbing the defense establishment of the necessary mandate for civil-military integration with the ICT and cyber industries to promulgate its Intelligent Defense Program.

  Exacerbating the situation was the government's occasional proclamation regarding the importance of the defense application to act as the engine that drives the industry for the country's economic gains, a practice that the Cyber Force suffered much under.[74] Such a practice is curious, given the already above-OECD average level of public investment in technology development

72 Liu/Shih, New Economic Development Opportuntities for Taiwan in the Post-ECFA Era.
73 National Development Council, 六大核心戰略產業推動方案.
74 總統府, "總統出席「國防部參謀本部資通電軍指揮部編成典禮」."

that the government has been able to maintain over the past decade or so, especially with the recent focus on chips, AI, and generative AI.

- **Observation 3: A bottlenecked civil-military defense innovation ecosystem**
  An obvious bottleneck, and potential explanation for Taiwan's lack of fielded examples of defense AI lies with the NCSIST. Any development into an operational application that is deemed even remotely sensitive would eventually have to pass through its doors. Yet this is an institution plagued with corruption scandals,[75] ineffective auditing mechanisms that resulted in significant delays in the delivery of major weapons systems, and an inability to prevent revolving doors from taking place between the institute and the defense establishment.[76]

Would a revised, more comprehensive, yet top-down approach on defense innovation, focusing on a select few applications and approaches, with more clear communications to stakeholders, be a more profitable approach? Probably not.

The answer may lie in a more grass-root and less restrictive approach to the development and adaptation of defense AI, especially from the civilian realm of applications. There is certainly no shortage of talents from the civilian side of the equation, with the Minister of Digital Affairs Audrey Tang among TIME magazine's 100 most influential AI figures of the year,[77] and innovators winning awards on AI applications all over the world.[78] The challenge seemed to be on setting up the appropriate infrastructure where Taiwan's defense establishment can properly benefit and harness from grassroots civilian efforts without a preconceived notion of what the developmental pathway should be. To this end, a few policy recommendations may be beneficial in accelerating the process:

- **Stop leveraging defense innovation and industry for economic gains**
  The government should recognize the urgency and priority of Taiwan's defense needs and focus both the defense innovation system and the defense industry at large on the overriding goal of ensuring Taiwan's security against the threat posed by China. This would mean an assessment of what sort of defense industry Taiwan needs to maximize its resiliency and self-sufficiency under various Chinese coercive scenarios, instead of attempting to devote government subsidies and issue policy directives based on an unobtainable win-win scenario where defense innovation and industry can enhance the economy while fulfilling defense needs. Once such a comprehensive assessment is made, the relevant economic trade-offs of such an assessment should be made clear to

75 楊國文, "中科院爆集體貪污弊案 中校先收賄26萬才退伍."
76 楊丞彧 et al., "中科院旋轉門疑慮 監院糾正國防部."
77 Serhan, "Audrey Tang: Minister of Digital Affairs, Taiwan."
78 張淮壕, "2023KIDE國際發明展建國科大奪12獎！AI創新璀璨."

the public before implementation. It also means that the government needs to proactively leverage civilian industries to fulfill defense needs by going out to the civilian industries and leveraging existing government bureaucracies outside of the defense establishment to do so, making a clear distinction between what strategic goals in Taiwan's defense the government wish to achieve without unnecessarily constrain operational and tactical approaches that may benefit from a vibrant civilian sector.

- **Flatten defense RDTE organization and security considerations**
  The bottleneck represented by NCSIST and associated organizations within the defense industry development institutions must be alleviated. Consequently, a conscious, well-researched, well-informed trade-off between operational security and the ability of the defense establishment to benefit from civilian innovation must be made. Instead of a centralized and siloed approach based on clearance levels, and instead of issuing problems seeking solutions, a redesigned ecosystem should attempt to let the solutions be presented seeking potential applications from a democratized defense innovation ecosystem involving multiple operational stakeholders.

- **Establish an experimental unit for "roadshow"**
  The previous two recommendations are really aimed at fostering an environment that would be more conducive to a bottom-up approach to defense innovation. But to spark such transformation, a small and nimble unit that can go around in a "roadshow" fashion, with both the authority and budget to experiment on solutions to various defense challenges and collect results for evaluation by both the defense and civilian establishment, would be crucial. The Ministry of National Defense Department of Integrate Assessment, a direct counterpart to the US Department of Defense's Office of Cost Assessment and Program Evaluation (CAPE) office, is ideally placed to take advantage of this approach, should the relevant budgetary authority be granted.

- **Emphasize potentially profitable approaches for Taiwan's defense AI**
  AI-enhanced real-time translation using large language models, capable of enhancing joint training and operation between US and Taiwan forces, would also be an initiative that leverages the asymmetric advantage between the US and its allies against the solitary nature of Chinese forces. Additionally, applications that can leverage Taiwan's decades of consistent data collection of its surrounding operational environment, such as algorithmic optimization of decoys and smart sea mines, could also prove to be a profitable approach.[79]

79 Mitre/Bajraktari, "These Technologies Could Defeat China's Missile Barrage and Defend Taiwan: Analysis."

Literature

"DARPA Tiles Together a Vision of Mosaic Warfare," undated, https://www.darpa.mil/work-with-us/darpa-tiles-together-a-vision-of-mosiac-warfare (last accessed 22 February 2024).

Ani, "Taiwan, Singapore resume military cooperation after long hiatus: Report." Business Standard, 18 December 2021, https://www.business-standard.com/article/international/taiwan-singapore-resume-military-cooperation-after-long-hiatus-report-121121800093_1.html (last accessed 22 February 2024).

Fish, Tim, "Uncrewed ambitions of the Loyal Wingman," Air Force Technology, 1 November 2022, https://www.airforce-technology.com/features/uncrewed-ambitions-of-the-loyal-wingman/ (last accessed 22 February 2024).

Lee, His-min and Eric Lee, "2020. Taiwan's Overall Defense Concept, Explained," The Diplomat, 3 November 2020 https://thediplomat.com/2020/11/taiwans-overall-defense-concept-explained/ (last accessed 22 February 2024).

Liu, Da-Nien; Shih, Hui-Tzu, New Economic Development Opportunities for Taiwan in the Post-ECFA Era (Paris: IFRI Center for Asian Studies, 2021), https://www.ifri.org/sites/default/files/atoms/files/av51complet.pdf (last accessed 22 February 2024).

Losey, Stephen, "How autonomous wingmen will help fighter pilots in the next war," Defense Nes, 15 February 2022, https://www.defensenews.com/air/2022/02/13/how-autonomous-wingmen-will-help-fighter-pilots-in-the-next-war/ (last accessed 22 February 2024).

Ministry of Economic Affairs, "Unmanned Vehicles Technology Innovative Experimentation Act," 19 December 2018, https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=J0030147 (last accessed 22 February 2024).

Ministry of National Defense, National Defense Review (Taipei: Ministry of National Defense, 2021), https://www.mnd.gov.tw/NewUpload/%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E7%B6%B2%E9%A0%81%E5%B0%88%E5%8D%80/%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80.files/%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8-110/110%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8-%E8%8B%B1%E6%96%87%E7%89%88.pdf (last accessed 22 February 2024).

Ministry of National Defense. Quadrennial Defense Review (Taipei: Ministry of National Defense, 2021), https://www.mnd.gov.tw/NewUpload/%e6%ad%b7%e5%b9%b4%e5%9c%8b%e9%98%b2%e5%a0%b1%e5%91%8a%e7%b8%bd%e6%aa%a2%e8%a8%8e(QDR)/%e6%ad%b7%e5%b9%b4%e5%9c%8b%e9%98%b2%e5%a0%b1%e5%91%8a%e7%b8%bd%e6%aa%a2%e8%a8%8e(QDR).files/%e6%ad%b7%e5%b9%b4%e5%9c%8b%e9%98%b2%e5%a0%b1%e5%91%8a%e7%b8%bd%e6%aa%a2%e8%a8%8e(QDR)-110/110%20QDR(%e8%8b%b1%e6%96%87%e6%ad%a3%e5%bc%8f%e7%89%88).pdf (last accessed 22 February 2024).

Ministry of Science and Technology. 2020. **科技部徵求110年「學研中心」專案計畫，自即日起至109年12月15日止**. National Taipei University of Technology Office of Research and Development. https://rnd.ntut.edu.tw/p/404-1042-104779.php?Lang=zh-tw (last accessed 22 February 2024).

Mitre, Jim and Ylber Bajraktari, These Technologies Could Defeat China's Missile Barrage and Defend Taiwan: Analysis," The RAND Blog, 24 August 2023, https://www.rand.org/pubs/commentary/2023/08/these-technologies-could-defeat-chinas-missile-barrage.html (last accessed 22 February 2024).

Motley, Julie Obenauer, "The testing and explainability challenge facing human-machine teaming," Brookings, 31 March 2022, https://www.brookings.edu/articles/the-testing-and-explainability-challenge-facing-human-machine-teaming/ (last accessed 22 February 2024).

National Development Council, **六大核心戰略產業推動方案** (Taipei National Development Council, 2021), https://www.ndc.gov.tw/Content_List.aspx?n=9614A7C859796FFA (last accessed 22 February 2024).

Serhan, Yasmeen, "Audrey Tang: Minister of Digital Affairs, Taiwan," TIME Magazine, 7 September 2023, https://time.com/collection/time100-ai/6308288/audrey-tang/ (last accessed 22 February 2024).

Thomas, William. 2023, "FY23 Budget Outcomes: Department of Defense," FYI Science Policy News,

24 February 2023, https://ww2.aip.org/fyi/2023/fy23-budget-outcomes-department-defense#:~:text=The%20budget%20for%20the%20Department,over%20the%20past%20six%20years (last accessed 22 February 2024).

Tucker, Patrick, "An AI Just Beat a Human F-16 Pilot In a Dogfight — Again," Defense One, 20 August 2020, https://www.defenseone.com/technology/2020/08/ai-just-beat-human-f-16-pilot-dogfight-again/167872/ (last accessed 22 February 2024).

中山大學，"智慧操控水下載具平台技術研發學研中心設置要點，" 中山大學, 2021, https://ora.nsysu.edu.tw/static/file/45/1045/img/2721/845868214.pdf (last accessed 22 February 2024).

中山新聞，"培育國防科技人才 中山大學成立「智慧操控水下載具學研中心」" 中山大學, 7 September 2021, https://news.nsysu.edu.tw/p/406-1120-267085,r2910.php?Lang=zh-tw (last accessed 22 February 2024).

中興大學，"第 94 次校務會議會議紀錄" 中興大學, 15 October 2021, https://secret.nchu.edu.tw/file-manager/02_admin/school_meet/94/94.pdf?_t=1626915054 (last accessed 22 February 2024).

中華民國空軍，"空軍任務，" 中華民國空軍, 2018, https://air.mnd.gov.tw/TW/About/About_Detail.aspx?ID=3 (last accessed 22 February 2024).

中華民國陸軍，"人工智慧結合擴增實境的軍事應用專題講演" Facebook, 7 October 2020, https://www.facebook.com/ROC.armyhq/posts/3332539593460504/?paipv=0&eav=AfZGD7hSgkt8pMNxpWVZ-Kr222J3i-pz3zFU7ZhnAz3ul5n3ujx62UyUa6xbW-D8i-PAM&_rdr (last accessed 22 February 2024).

方志賢，"推動全民國防教育 AI無人機、無人車納入活動、模擬戰場實況，" 自由時報, 22 March, 2022, https://news.ltn.com.tw/news/life/breaking-news/3845885 (last accessed 22 February 2024).

王儷華，"防止人類生存被威脅台灣將推AI基本法，會如何監管？，" Commonwealth Magazine, 12 December 2023, https://www.cw.com.tw/article/5128521 (last accessed 22 February 2024).

"台灣全球倒數第一無解的難題，" 自由時報, 4 December 2023, https://ec.ltn.com.tw/article/breaking-news/4507422 (last accessed 22 February 2024).

主計處，"中央政府總預算及附屬單位預算，" 主計處, Undated, https://www.dgbas.gov.tw/cp.aspx-?n=3623&s=1208#Anchor_11333 (last accessed 22 February 2024).

成功大學，"國防關鍵系統研究發展中心，" 成功大學, 19 January 2022, https://wtrc.web2.ncku.edu.tw/p/412-1177-25426.php?Lang=zh-tw (last accessed 22 February 2024).

朱明，"提升空軍防空飛彈攔截效能 「寰網」聯戰採以色列系統作為主要核心技術，" Up Media, 9 December 2021, https://www.upmedia.mg/news_info.php?Type=1&SerialNo=132001 (last accessed 22 February 2024).

朱泓任，"臺灣AI元年 科技部5年160億打造AI新生，" Newtalk新聞, 24 October 2017, https://newtalk.tw/news/view/2017-10-24/101480 (last accessed 22 February 2024).

行政院，"台灣AI行動計畫—掌握契機，全面啟動產業AI化，" 行政院, 7 August 2019, https://www.ey.gov.tw/Page/5A8A0CB5B41DA11E/a8ec407c-6154-4c14-8f1e-d494ec2dbf23 (last accessed 22 February 2024).

行政院主計總處，"國民所得統計，" 經濟數據統計分析系統, 2023, https://dmz26.moea.gov.tw/GA/common/Common.aspx (last accessed 22 February 2024).

行政院國家科學委員會，"國家科學技術發展計畫 (民國 102 年至 105 年)，" 行政院國家科學委員會, 3 October 2013, https://www.nstc.gov.tw/nstc/attachments/4b27e75d-7fa3-4ff9-879b-8329e06ff83f (last accessed 22 February 2024).

呂雪彗，" 因應地緣政治 賴清德主打五大信賴產業，" 工商時報, 26 August 2023, https://www.ctee.com.tw/news/20230826700224-430104#:~:ext=%E5%9B%A0%E6%87%89%E5%9C%B0%E7%B7%A3%E6%94%BF%E6%B2%BB%E8%AE%8A%E5%8C%96%EF%BC%8C%E5%89%AF,%E5%9C%8B%E9%9A%9B%E-5%8F%AF%E4%BF%A1%E8%B3%B4%E5%90%88%E4%BD%9C%E5%A4%A5%E4%BC%B4%E3%80%82 (last accessed 22 February 2024).

李恬郁，"國軍後勤AI推手 原來是他！，" Youth Daily News, 16 August 2019, https://tw.news.yahoo.com/%E9%9F%9C%E7%95%A5%E7%8B%80%E5%85%83-%E5%9C%8B%E8%BB%8D%E5%BE%8C%E5%8B%A4ai%E6%8E%A8%E6%89%8B-%E5%8E%9F%E4%BE%86%E6%98%AF%E4%BB%96-160000438.html (last accessed 22 February 2024).

周昇煒，"國防部邀國網中心辦理AI發展講座 建構專業能量，" 軍聞社, 14 October 2019, https://www.nchc.org.tw/Message/MessageView/3320?mid=46&page=1 (last accessed 22 February 2024).

林柏州, “「智慧國防計畫」與國防科技機制發展,” 國防安全雙週報, 27 September 2019, https://indsr.org.tw/respublicationcon?uid=12&resid=729&pid=2868 (last accessed 22 February 2024).

科技部, “人工智慧科研發展指引” 科技部, September 2019, https://www.nstc.gov.tw/nstc/attachments/53491881-eb0d-443f-9169-1f434f7d33c7 (last accessed 22 February 2024).

科技部, “111 年度科技部「國防科技探索專案計畫」徵求公告,” 國科會, 2022, https://www.nstc.gov.tw/nstc/attachments/5a383553-47a2-481e-9194-f8ebd0573304 (last accessed 22 February 2024).

科技部工程司, “國防科技探索專案公告說明會,” 科技部, 23 May 2023, http://www.etop.org.tw/index.php?d=epp&c=epp12911&m=download_attachment&post_id=1412&id=1209 (last accessed 22 February 2024).

范正, “落實國防自主政策 中科院預算連續兩年破千億,” 中央社, 16 September 2023, https://www.cna.com.tw/news/aipl/202309160112.aspx (last accessed 22 February 2024).

范瑜, “ 國醫、三總攜手廣達 打造心電圖AI判讀平臺,” Youth Daily News, 2 August 2023, https://www.ydn.com.tw/news/newsInsidePage?chapterID=1604491 (last accessed 22 February 2024).

徐振威, “「故障預判」交給AI！導入航空發動機監控系統保飛安,” 軍聞社, 31 October 2018, https://www.ettoday.net/news/20181031/1295089.htm (last accessed 22 February 2024).

徐葳倫, 黃昭盛, “71年首次 空軍作戰指揮部”封洞”清消,” 華視, 14 June 2021, https://news.cts.com.tw/cts/life/202106/202106142046050.html (last accessed 22 February 2024).

涂鉅旻, “中科院推智慧國防10年計畫,” 自由時報, 2 September 2019, https://news.ltn.com.tw/news/politics/paper/1314948 (last accessed 22 February 2024).

袁佳慶, “導入人工智慧對話式機器人教學以提升國軍飛機修護訓練成效,” 國立臺中教育大學教育資訊與測驗統計研究所, 6 January 2022, https://ndltd.ncl.edu.tw/cgi-bin/gs32/gsweb.cgi/login?o=dnclcdr&s=id=%22110NTCT0629001%22.&searchmode=basic (last accessed 22 February 2024).

國家中山科學研究院, “財務資訊 “, 中科院, Undated, https://www.ncsist.org.tw/csistdup/aboutus/page07.html (last accessed 22 February 2024).

國立台灣大學, “國臺灣大學國防科技學研中心設置要點,” 國立台灣大學, 10 November, 2021, https://ntuvp.ntu.edu.tw/centers/R50.pdf (last accessed 22 February 2024).

國防大學理工學院, “歷史沿革,” 國防大學理工學院, Undated, https://www.ccit.ndu.edu.tw/Unit/100023/24418 (last accessed 22 February 2024).

國防, “106年國防報告書” P. 165, 國防部, 26 December 2017, https://www.mnd.gov.tw/PublishForReport.aspx?title=%E8%BB%8D%E4%BA%8B%E5%88%8A%E7%89%A9&Types=%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80&SelectStyle=%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80 (last accessed 22 February 2024).

國防部, “110年國防報告書” P. 129, 國防部, 9 November 2021, https://www.mnd.gov.tw/PublishForReport.aspx?title=%E8%BB%8D%E4%BA%8B%E5%88%8A%E7%89%A9&Types=%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80&SelectStyle=%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80 (last accessed 22 February 2024).

國防部, “110年國防報告書” P. 178, 國防部, 9 November 2021. https://www.mnd.gov.tw/PublishForReport.aspx?title=%E8%BB%8D%E4%BA%8B%E5%88%8A%E7%89%A9&Types=%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80&SelectStyle=%E6%AD%B7%E5%B9%B4%E5%9C%8B%E9%98%B2%E5%A0%B1%E5%91%8A%E6%9B%B8%E5%B0%88%E5%8D%80 (last accessed 22 February 2024).

國防部, “國防部 112 年「國防先進科技研究計畫」評鑑實施計畫,” 國防部, 13 December 2023, https://www2.nutn.edu.tw/randd/upload/120230619095859.pdf (last accessed 22 February 2024).

國防部, “國防部111年「國防先進科技研究計畫」申請書徵求主題一覽表(突破式國防科技研發計畫),” 國防部, 2022, http://rdar.rdo.fju.edu.tw/sites/rdar.rdo.fju.edu.tw/files/%E5%BE%B5%E6%B1%82%E4%B8%BB%E9%A1%8C_0.pdf (last accessed 22 February 2024).

國防部, “ 國防部發布新聞稿說明行政院核列112年度國防部主管歲出預算,” 國防部, 25 August 2022, https://www.mnd.gov.tw/Publish.aspx?p=80285&title=%E5%9C%8B%E9%98%B2%E6%B6%88%E6%81%AF

&SelectStyle=%E6%96%B0%E8%81%9E%E7%A8%BF (last accessed 22 February 2024).

國防部軍備局, "112年「國防先進科技研究計畫」構想書," National Taiwan Normal University Office of Research and Development, 2023, https://www.acad.ntnu.edu.tw/files/news/10962_ece636c6.pdf (last accessed 22 February 2024).

清華大學, "清華大學國防科技學研中心," 清華大學, 2021, https://dod.site.nthu.edu.tw/ (last accessed 22 February 2024).

許劍虹, "許劍虹觀點：重空軍而輕海軍的蔣中正," 風傳媒, 19 November 2023, https://www.storm.mg/article/4899570 (last accessed 22 February 2024).

陳建源, "「人工智慧ＡＩ」無人艦艇軍事倫理問題初探," 海軍學術雙月刊第五十二卷第四期, 1 August 2018, https://navy.mnd.gov.tw/Files/Paper/2-%E4%BA%BA%E5%B7%A5%E6%99%BA%E6%85%A7%EF%BC%A1%EF%BC%A9.pdf (last accessed 22 February 2024).

陳穎信, 戴明正, 許秀珠, 程學儒, "建構MR心肺復甦術+AED教學系統," 財團法人生技醫療科技政策研究中心, 23 December 2020, https://innoaward.taiwan-healthcare.org/award_detail.php?REFDOCTYPID=0mge2rck644mcfl0&num=1&REFDOCID=0qls4a5ph377cqqq (last accessed 22 February 2024).

陳鈺馥, "國軍運用AI 發展不對稱戰力," 自由時報, 11 September, 2023, https://news.ltn.com.tw/news/politics/paper/1604187 (last accessed 22 February 2024).

陸軍飛彈光電基地勤務廠, "運用 AI 智慧技術優化防空裝備發射暨支撐機構系統開發," 陸軍飛彈光電基地勤務廠, Undated, https://ord.nccu.edu.tw/download.php?filename=1471_1ade29f6.pdf&dir=rd_research&title=%E7%A0%94%E7%A9%B6%E8%A8%88%E7%95%AB%E6%A7%8B%E6%83%B3%E6%9B%B8. (last accessed 22 February 2024).

張延廷, "國軍訓練 AI可代勞," 自由時報, 5 August 2023, https://www.chinatimes.com/opinion/20230805003387-262104?chdtv (last accessed 22 February 2024).

張淮壕, "2023KIDE國際發明展 建國科大奪12獎！AI創新璀璨," 創新聞, 13 December 2023, https://n.yam.com/Article/20231213466388 (last accessed 22 February 2024).

張玲玲, "科技結合創新 建構智慧國防, Youth Daily News, 3 September 2023, https://www.ydn.com.tw/news/newsInsidePage?chapterID=1612391&type=forum (last accessed 22 February 2024).

楊丞彧, 陳鈺馥, "中科院旋轉門疑慮 監院糾正國防部," 自由時報, 22 September 2023, https://news.ltn.com.tw/news/politics/paper/1606160 (last accessed 22 February 2024).

楊國文, "中科院爆集體貪污弊案 中校先收賄26萬才退伍," 自由時報, 13 December, 2022, https://news.ltn.com.tw/news/society/breakingnews/4153805 (last accessed 22 February 2024).

楊孟臻, "資通電軍指揮部成立 蔡英文交付3項任務," Up Media, 29 June 2017, https://www.upmedia.mg/news_info.php?Type=24&SerialNo=19855 (last accessed 22 February 2024).

楊策淳, 劉律寬, "國軍戰術戰傷救護模擬訓練之成效分析與鏈結AI人工智慧發展," 陸軍後勤季刊109年第二輯, May 2020, https://www.airitilibrary.com/Article/Detail/P20230131001-N202303040016-00002 (last accessed 22 February 2024).

陽明交通大學, "前瞻科技與系統學術研究中心," 陽明交通大學, Undated, https://fsc.nycu.edu.tw/ (last accessed 22 February 2024).

賴品瑀, "整合科技研發與作戰運用 智慧國防十年計畫促臺灣成世界核心," 智慧國家, 11 July 2023, https://2030.tw/article/Digital-Strategy-for-Defence-033-Fiber-Li (last accessed 22 February 2024).

蕭佳宜, "管理學院科技教學 深化國軍訓練效能," Youth Daily News, 25 March 2023, https://www.ydn.com.tw/news/newsInsidePage?chapterID=1574154 (last accessed 22 February 2024).

蘇思云, "培育7大領域科研人才 科技部攜手國防部5年砸50億," 中央社, 16 December 2020, https://www.cna.com.tw/news/ait/202012160073.aspx (last accessed 22 February 2024).

蘇恩民, "失控主持人1 國安危機！50億軍武科技研發保防破大洞？," 民視新聞網, 8 Decemebr 2023, https://tw.news.yahoo.com/%E7%8D%A8%E5%AE%B6-%E5%A4%B1%E6%8E%A7%E4%B8%BB%E6%8C%81%E4%BA%BA1-%E5%9C%8B%E5%AE%89%E5%8D%B1%E6%A9%9F-50%E5%84%84%E8%BB%8D%E6%AD%A6%E7%A7%91-%E6%8A%80%E7%A0%94%E7%99%BC%E4%BF%9D%E9%98%B2%E7%A0%B4%E5%A4%A7%E6%B4%9E-192749192.html (last accessed 22 February 2024).

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