Navigating the Realm of Artificial Intelligence in AirC2, Education, Training, Exercise, and Evaluation

By Lieutenant Colonel Mark Meeuwissen, BEL Air Force, JAPCC

Introduction

Artificial Intelligence (AI) is not new in the military context. Often, however, AI is misunderstood as software able to create autonomous weapons systems (aircraft, robots, decision-making tools, etc.). Both the civilian and military realms have already been working for a long time to develop algorithms to deliver ever-greater levels of automation. In simple terms, generative AI is the technology that enables machines to generate new content. Unlike traditional automation, which follows predefined rules and patterns, generative AI leverages complex algorithms and neural networks to create something entirely new. As explained in Thinkbridge, 'It's important, however, to remember that this new creation is only based on the data used to train the AI model, which is the foundational cornerstone of generative AI. This is not an actual conception in the sense of a unique offering but something created to represent a specific ask of a user to the best of the model's ability.'[1]

There are several demand signals to explain the current AI boom that we notice in the military and civilian worlds. The main signals include, but are not limited to, decision speed, the ability to deal with big data, and the potential efficiencies to mitigate manpower shortages.

In the military environment, these advantages are not only 'nice to have' but rather a potentially decisive advantage in successfully conducting operations. Modern warfare requires processing a vast amount of data in

ever-shrinking timeframes. In addition, many Allies have encountered increasing difficulties in recruiting, training, and retaining the required number of military personnel. Therefore, our expectations of AI have become to process as much data as possible in a very short amount of time with the least possible personnel.

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This article applies our expectations of AI to two realms, (Air-) Education, Training, Exercise, and Evaluation (ETEE), and the Air Command and Control (AirC2) function, and asks: How can AI contribute? Although focused on the air domain, the observations should generally apply to the other domains.

AI in ETEE

The most significant contribution AI can give to ETEE will be saving manpower since effective ETEE is so labour-intensive. Students are taught, examined, and corrected to enhance their professional skills, with multiple repetitions and exercises to stay current. Evaluations need to make sure that personnel are trained to NATO standards. One common denominator in ETEE events is human supervision and organization, thereby taxing available manpower. They define the education, organize the training, build the exercises, run the scenarios, introduce injects, and steer the evaluation to meet training objectives. If the supervision function (monitoring and correcting the soldiers' actions) could at least partly be supported or taken over by AI, it would significantly reduce the manpower requirement.

In late 2017, NATO Allied Command Transformation (ACT) initiated a study titled 'AI in AirC2 Planning & ETEE'. The German Air Force led this study, supported by ACT, Subject Matter Experts (SMEs) from the German and French Air Forces, and the Joint Air Power Competence Centre. Finally, in 2018, a contract was awarded to CAE[2] to provide deliverables such as analysis, a demonstrator (software), and progress reports. The study investigated the development and use of AI in the AirC2 planning cycle in a Joint Force Air Component (JFAC) Headquarters (HQ). The second objective was to assess to what extent AI can contribute to ETEE in the JFAC by creating options during planning, thus speeding up planning and freeing up resources.

The study collected data on the challenges experienced by the staff throughout the planning process during a high-intensity command post exercise (CPX) in 2019. The German Air Force identified several planning tasks as potential candidates for further study, of which the offensive Composite Air Operations (COMAO) planning was the highest workload for planners. The scarcity of COMAO planners, the time constraints during planning, and the considerable amount of data necessary for the process consequently became the primary focus of the study. CAE also used the 2019 exercise to learn how AirC2 is conducted, enabling development of the demonstrator.

The study focused on building a demonstrator, consisting of an agent that can create an offensive COMAO in almost no time. This includes the targeting process (matching assets and their weapons with targets), adherence to SUPPLAN M (routing), reactions to the Red ORBAT (Order of Battle), etc. As it was the first demonstrator, some limitations were imposed: only known targets were attacked, and there were no night operations or weather limitations. Should the agent be considered for operational use, the technological future will look promising. The agent may also expand to include other planning processes, such as defensive fighter operations or others.

In February 2022, before the start of the exercise Kalkar Sky,[3] the AI agent was deployed after learning from thousands of COMAO-based scenarios. During the exercise, the JFAC commander at Kalkar Sky received the agent's COA based on the same available

data that the human planners had at their disposal. By changing the parameters, multiple COAs were generated by the agent in a very short period of time. This allowed the commander to choose the best human or AI-generated option based on his knowledge and prevailing instructions.

Within the imposed limitations, the AI agent demonstrated that, for any given mission, it could provide a limited air plan within 30 seconds. The speed of the AI agent could also allow the human planners to immediately use the AI-provided plan as a baseline, upon which they could add further details such as timings, scheduling, and multi-mission aspects. This could save considerable time for the human planner and enable the generation of multiple plans for a given mission. Although the testing of this AI was conducted only on a very small scale, the AI agent proved successful.

After conducting the exercise and finishing the report, the German Air Force sought support and cooperation within NATO organizations and individual nations to continue this project and expand the use of AI in AirC2. In order for the procurement process to continue, more NATO nations must stand behind the exploration and expansion of AI in AirC2 Planning & ETEE. Only then can the procurement process be enabled to integrate properly scoped AI into NATO C2 and ETEE.

While the focus of exercise Kalkar Sky 2022 was testing the AI agent, other aspects could not be evaluated in detail, namely red air inputs, white cell interaction, defensive fighter operations, Air-to-Air Refuelling (AAR), and others. The German Bundeswehr University in Munich delivered the software for the demonstrator and is still improving it with the help of better and more robust hardware. This could address the missing aspects in future. Red air inputs

The Ramstein Flag 2024 exercise marked NATO's inaugural Flag exercise, highlighting a cutting-edge training concept. More than 130 fighters and enablers participated in joint training sessions aimed at enhancing tactics and promoting stronger integration among forces.

and white cell interaction are enablement functions where AI could be particularly beneficial since the impact on actual operations is non-existent. Therefore, the risk of expanded use of AI (limited to ETEE) is low.

In parallel, the project and its results were discussed during the Ramstein AB Tech Expo[4] and the Think Tank for Information Decision and Execution (TIDE) Sprint[5] in Dresden in March 2024. This should promote further development and support from NATO, NATO entities, and NATO Allies. No additional actions are planned so far, and organizers are currently focused on advertising the results of the study, with the aim of finding a team within NATO that will proceed with further development of AI in AirC2.

AI in AirC2

C2 is 'the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission.'[6] The C2 system consists of people, organizations, processes, methods, and equipment. The products of a C2 system are orders.[7] To generate orders, the system needs to facilitate data collection, reasoning, sensemaking, and planning.

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In today's fast-paced world, the sheer volume of data, multitude of connections, and need for quick decision-making necessitate reliable support systems. AI has the potential to revolutionize certain processes and enhance human decision-thinking.

This article will focus on the JFAC HQ as the hub of a larger AirC2 enterprise. The main product delivered by this HQ is the daily Air Tasking Order (ATO), which informs all concerned units what exactly they must do, when, and where. This order is the result of detailed planning by the Combat Plans Division. An ATO cycle takes 72 hours, from planning to execution. This means that the JFAC HQ is working on multiple ATOs at any time. Besides these ATOs, other plans and orders are generated daily by the JFAC HQ, including Airspace Control Order (ACO), Special Instructions (SPINS), and Operational Tasking Data Link (OPTASK LINK).

AirC2 is a complex and comprehensive set of processes, many of which depend on human judgement, so AI can only replace some human beings in the JFAC HQ to do the entire planning. Therefore, we should consider what tasks where AI would be most beneficial or most readily integrated into AirC2. In other words, what can AI do to make AirC2 more efficient? From this perspective, saving manpower, expediting the planning process, and working more efficiently are three interconnected tasks that can benefit significantly when supported by AI technology.

Saving manpower would probably not be the first or most significant benefit for a JFAC HQ. For every operation, the JFAC HQ is tailored to specific aspects of that operation, such as the objectives, potential targets, number of adversaries, weaponry used by opponents, geographical considerations, threat level, acceptable level of risk, available capabilities, etc. As a JFAC HQ is often undermanned, reducing manpower requirements is an immediate benefit. Deleting entire cells or sections may not be possible, but properly scoped and trained automation, applied to appropriate tasks, could mitigate shortfalls. Such tasks include routine processes that operate within defined parameters, categorization and calculation of large data sets, and other intermediate functions that do not require human judgment. This allows humans to supervise and incorporate automated outputs while focusing on their essential tasks.

However, the potential of AI to accelerate the planning process (72-hour ATO production cycle) may resonate even more with leaders and practitioners. Every operation is, by default, a very dynamic situation where the location of the adversaries, their movement, possible targets, and threat level continuously evolve. AI could accelerate the evaluation of these changing parameters, shortening the ATO development cycle. On the other hand, we also need to realize that AI cannot accelerate all aspects of the ATO cycle. A significant reason for the ATO timeline is to build enough lead time and predictability for execution, and to think several days in advance

on resource planning (munitions, aircraft, surge considerations, etc). AI cannot accelerate this.

Finally, using AI in the ATO planning cycle promotes efficiency by streamlining activities where human operators must manually manipulate and transfer data between incompatible systems. The current planning cycle is supported by software throughout NATO forces, mainly Integrated Command and Control (ICC). However, human interaction, assessment, and interpretation are needed during several phases of the ATO generation. This results in time-consuming activities for humans and interpretation and assessment mistakes where not all options are looked at or not in the required detail due to time constraints. It would have a significant impact If AI could accomplish these routine tasks with higher accuracy.

In addition to the COMAO planning discussed earlier in this article, other planning activities are very time-consuming, such as AAR planning. This is because multiple parameters, restrictions, and considerations must be taken into account. AAR planning was not tested during the study, but it is just one example of planning tasks worthy of further investigation for AI augmentation.

Challenges

Despite our optimism about AI, military tasks are special and have special consequences. Therefore, we should be frank about the challenges, ranging from training to reliability and transparency with AI-delivered products and processes.

AI is typically considered a subset of software. This means that if AI can enhance AirC2, it needs to be embedded in, or at least compatible with, the AOC weapons system, the software or applications used in AirC2 being part of it. Most commonly, NATO uses ICC in AirC2, a software that has existed for many decades and is still undergoing updates and maintenance. Besides supporting the planning cycle, ICC is also used for tasks like battle management, C2, and reporting. Another AirC2 tool is the Air Command and Control System (ACCS), currently under procurement by the NATO Communications and Information Agency, with the same functionalities as ICC. If ACCS, or any other future system is adopted, it will face the same limitations and challenges as ICC: compatibility when using or embedding AI in existing software.

The key question in a big organization like NATO is: When implementing AI in AirC2, how do you do it right? NATO should establish parameters, guidelines, and priorities for incorporating automation that concisely address these 'how to do it right' concerns. Assessing AI's capabilities, defining the task and work, and looking for non-obvious use cases can be of great help.[8]

There are other challenges which must be mentioned. Software modifications are costly and very time-consuming due to the development, testing, evaluation, implementation, and more. Not all nations use ICC or ACCS, so burden-sharing must be discussed in parallel. Even the composition of the software will have to be discussed, such as political or legal considerations, national interests, and what needs to be included.

The application of AI in ETEE and AirC2 will require more standardization and cooperation between nations and HQs. If not, a possible proliferation of systems and applications could prevent smooth and coordinated operations by all NATO Allies.

Finally, AI-driven systems and programs are very powerful. This also means that in the case of compromise or cyberattack, the consequences could vary from considerable to catastrophic. Robust protection of all AirC2-related systems and programs will be required, and systems and processes must be developed so trained and knowledgeable workers can always pick up the process.

Conclusions

Improving the capabilities of AI algorithms is necessary for mission commanders to keep pace with the increasing velocity and complexity of warfare. For the future battlefield, there will be a need to develop agile and adaptive AI-support tools that are faster, better and cheaper than the existing ones, under the primary assumption that the future flow of information and speed of operation will likely exceed the capabilities

of the current human staff if the C2 processes remain largely manual.[9] Decision speed, accuracy, and efficiency will become increasingly difficult if AirC2 and ETEE are limited by human inputs and reasoning since the amount of data to be processed and considered will only increase in quantity and complexity.

The answer to the question, 'Do we really need AI in AirC2 and ETEE?' is undoubtedly 'Yes'. However, as discussed in previous paragraphs, we must keep in mind the implications and consequences we face. Can we deal with the associated challenges and limitations? Are we asking AI and automation to accomplish the correct tasks in the correct way?

Not that AI can be integrated into AirC2 and ETEE in the blink of an eye, but if NATO wants to be ahead of the game, an incremental approach to incorporate AI over time is a must. ●

1. Krishnan, A., Mitra, S. and Zarkadas, A., Thinkbridge, [website], 2024, What Is The Difference Between Generative AI And Automation? (accessed 30 August 2024).
2. CAE: Canadian Aviation Electronics Ltd.
3. Kalkar Sky: the computer-assisted exercise Kalkar Sky took place in February 2022 to certify the German Joint Force Air Component (JFAC) Command to take place in Very High Readiness Joint Task Force (VJTF) 2023.
4. The Ramstein AB Tech Expo, also known as the Air Innovation Conference HQ AIRCOM, aims to foster innovation, collaboration, and education by bringing together government and industry to address mission requirements and technology solutions.
5. TIDE Sprints tackle interoperability from multiple perspectives, including people, processes, and technology, by encouraging operators, engineers, scientists, and academics to share ideas and collaborate on current and future solutions.
6. Voke, M., R., 'Artificial Intelligence for Command and Control of Air Power', The Wright Flyer Papers, no. 72, 2019, pp. 1–35.
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8. Valliani, J., 2024, A Guide to Adopting AI Features in Your Company. Atlassian, products and news, published 26 June. Available from A Guide to Adopting AI Features in Your Company – Work Life by Atlassian (accessed 30 July 2024).
9. Goecks Vinicius, G., Waytowich, N., Asher Derrik, E., Park, S., Mittrick, M., Richardson, J., Vindiola, M., Logie, A., Dennison, M., Trout, T., Narayanan, P., and Kott, A., 2023, On games and simulators as a platform for development of artificial intelligence for command and control. The Journal of Defense Modeling and Simulation, Volume 20, Issue 4, pp. 495–508.

ABOUT THE AUTHOR

Lieutenant Colonel Mark Meeuwissen

BEL Air Force, JAPCC

Lieutenant Colonel Mark Meeuwissen graduated from the Royal Military Academy Brussels in 1988 with a master's in military and Aeronautical Science. His career as a pilot was performed on F-16 in the Fighter-Bomber role and on NATO AWACS up to pilot-evaluator. On both platforms, he participated multiple times in several operations: Operation Deliberate Guard/Joint Falcon (Balkans), Baltic QRA (Air Policing), Afghan Assist, and Active Endeavour. Besides National Headquarters and Air Staff in the Operations and Planning Divisions, he fulfilled two CAOC tours, the first in the Training and Exercises Branch and the second as Defensive Planner in the Plans Division. He spent three years in Eindhoven in the EATC (European Air Transport Command) as supervisor for the European-American region. In September 2021, he joined JAPCC, where he was the Air Operations Planning SME. End of October 2024, he left JAPCC for a new assignment in the Requirements Division of the NAEW&CF HQ in Geilenkirchen.