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FUTURE ARTIFICIAL INTELLIGENCE APPLICATIONS IN THE UNITED STATES AIR FORCE AIR MOBILITY COMMAND

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FUTURE ARTIFICIAL INTELLIGENCE APPLICATIONS IN THE UNITED STATES AIR FORCE AIR MOBILITY COMMAND

By Major Chester A. Peyton III

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> *Real exploitation of air power's potential can only come through making assumptions that it can do something we thought it couldn't do . . . We must start our thinking by assuming we can do everything with air power, not by assuming that it can only do what it did in the past.*
>
> – Colonel John Warden

INTRODUCTION

Just one hour after a major earthquake in Sumatra, 20 hours after departing their base in California and two aerial refueling (AR) plugs later, two C-5M Super Galaxy cargo aircraft touchdown into Singapore's Paya Labar airfield carrying Humanitarian Assistance/Disaster Relief (HADR) supplies. On board is also an emergency response team, logistical support, and ground equipment for four United States (U.S.) Army UH-60 Blackhawk helicopters in the cargo bay of the C-5M's. Over the Indian Ocean, smaller single-piloted C-17 Globemaster cargo aircraft augmented with Artificial Intelligence (AI) have already been redirected from Southwest Asian missions to stage into austere island airfields. While autonomous systems are analyzing meteorological data to build efficient flight plans, autonomous aerial vehicles (AAV) are deployed to perform airfield suitability analysis of runway surfaces, map terrain and create ad hoc instrument approaches that will allow continuous air operations into earthquake damaged airfields. This rapid response had been triggered 36 hours prior when data pulled from global seismic sensors was analyzed by an AI deep learning machine.

Within milliseconds, this machine predicted with high certainty that a high magnitude earthquake along the Sumatra Trench would render high casualty rates and loss of property. Interconnected alert systems received worldwide warnings and Air Mobility Command's (AMC) automated scheduling systems immediately entered pilots into crew rest, alerted medical teams, readjusted the aircraft maintenance priorities, and automated palletizing and aerial port load-planning of HADR supplies. No lives were lost, not only because of the advanced warning and immediate response, but because this exact scenario never happened.

An earthquake in Indonesia followed by Tsunamis in multiple is not too far-fetched as one occurred in 2004, but the fictional response described above may one day be a reality once automated systems in development today are operational.[1] AMC of the USAF first introduced the Aerial Port of the Future (APotF) initiative in August of 2016.[2] The initiative is slow to yield command wide implementation, however the end game is to field "automation and artificial intelligence to improve aerial port efficiency and safety."[3] Expanding this futuristic concept across the entire AMC enterprise would extend beyond the scope of this paper, therefore, this paper's focus is directed primarily toward USAF airlift operations. The future of airlift operations as near-peer adversaries continue to advance their threat capability requires commitment toward implementing AI as its primary modus operandi with a well trained and educated human force to maintain an asymmetric offset.

AMC's mission is first introduced to give a synopsis of the missions it currently supports across the globe, issues currently afflicting the USAF and AMC, and the current AI technology used in accomplishing its operations. The following sections will discuss

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[1] "Boxing Day Tsunami: How the Disaster Unfolded 10 Years Ago," ABC, 23 December 2014, https://www.abc.net.au/news/2014-12-24/boxing-day-tsunami-how-the-disaster-unfolded/5977568.

[2] Peter J. Williams, "Aerial Port of the Future: Developing Paperless Options" (Air Force Institute of Technology Thesis Paper, Air Force Institute of Technology, 2018), 2.

[3] Brian w. Everstine, "AMC Studying Automation for Its Aerial Ports of the Future," Air Force Magazine, 30 October 2017, https://www.airforcemag.com/amc-studying-automation-for-its-aerial-ports-of-the-future/.

applications of AI that can help mitigate the identified issues and areas that AI can enhance the AMC mission. Implementation of this technology would pose new vulnerabilities that may exist within rather than from the adversary. The final section will highlight the Department of Defense's (DoD) third offset-strategy and how fixation on maintaining an asymmetric technological advantage may render forces ineffective. Even as trust in AI builds, the quality of the human force must not deteriorate.

MODERN AIR MOBILITY COMMAND MISSIONS AND PROBLEMS

First glance at the name Air Mobility Command does not make it inherently obvious for someone unfamiliar with its operations to realize AMC encompasses more than just warehouses of cargo, airplanes transporting equipment and personnel, and the supply chain framework that would accompany any major global freight organization. AMC is an entire enterprise whose mission is to "provide rapid, global mobility and sustainment for America's armed forces."[4] In order to rapidly sustain the United States' (U.S.) armed forces with combat equipment, supplies, and personnel, AMC's responsibility also includes aerial refueling and aeromedical evacuation (AE) in addition to airlift operations. Airlift operations also involves executing the Special Air Missions that provide "global transportation for America's senior leaders" which includes the President and Vice President of the U.S..[5] Volumes can and have been written on Air Mobility (AM) operations, however, this paper will focus on general concepts of airlift in order to convey the necessity for AI and autonomous systems. As "airlift operations are

[4] "Home," Air Mobility Command, accessed 28 March 2020, https://www.amc.af.mil/Units/.

[5] "89th Airlift Wing," Joint Base Andrews, accessed 28 March 2020, https://www.jba.af.mil/About-Us/Fact-Sheets/Display/Article/336383/89th-airlift-wing/.

defined by the nature of the mission rather than the airframe used," it makes it easier to focus on the effect rather than the platform.[6]

Two effects to consider are those required to execute HADR and combat missions. Similar to the hypothetical scenario in the introduction, the 2011 Tokyo earthquake and the damaged Fukushima nuclear plant initiated Operation Tomodachi. Airlift aircraft departed from the West and East coast of the U.S. carrying supplies conducting AR to ensure rapid deployment to Japan.[7] In addition to transportation of equipment, piloted and remotely piloted aircraft (RPA) conducted surveillance missions to assess radiation levels and infrastructure damage. AMC also sent "Aerial Port specialists, airspace planners, and an airfield assessment team" from its Contingency Response Wing to re-establish Northern Japanese airfields.[8] Non-Combatant Evacuations also took place with civilian contracted travel and AMC aircraft returning approximately 9000 military and their dependents back to the U.S..[9] The quick response and the sustainment that occurred during Operation Tomodachi's two and half month mission displayed the full array of rapid global mobility with one exception. Fortunately, the one exception was the need for aeromedical evacuation; AE is a mission that AMC has executed with a sustained 97% survivability rate for wounded combat warriors.[10]

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[6] Joint Chiefs of Staff, *Air Mobility Operations*, JP 3-17 (Washington, D.C.: Joint Chiefs of Staff, 2019). Additionally, older publications derived from the Air University Press at Maxwell Air Force Base such as Lt Col Charles E. Miller's *Airlift Doctrine* written in 1988 and Lt Col Michael Fricano's 1996 research report titled *The Evolution of Airlift Doctrine and Organization* paint a pre-9/11 picture of the doctrine that shaped the methods used in executing today's airlift mission.

[7] Rockie K. Wilson, "2011 - Operation Tomodachi," Air Force Historical Support Division, 10 March 2016, https://www.afhistory.af.mil/FAQs/Fact-Sheets/Article/690225/operation-tomodachi/.

[8] Wilson, "2011 – Operation Tomodachi."

[9] *Ibid*.

[10] "Air Mobility Command," Air Mobility Command, 15 June 2017, https://www.amc.af.mil/About-Us/Fact-Sheets/Display/Article/1517710/air-mobility-command/.

Unfortunately, the experience leading to this AE survivability statistic has come through real-world combat missions in combination with their force generation training.

The past two decades of combat operations has led to continuous deployments of AMC personnel continuing to improve their skill sets and learn how to become more efficient and effective. During operations across Southwest Asia, AMC personnel supported the fight with planners in Air Operations Centers, enablers in air and on the ground in hostile territory, and AM Liaison Officers embedded with joint units to effectively utilize air mobility in their operations.[11] AMC personnel are also executing similar sustainment and response missions in combat as those described in HADR operations. The importance of this section is to highlight the vastness of AM and the footprint required to operate the AMC mission. As more Americans believe that the government must spend less on defense, the military requires more fiscal responsibility to maintain the trust it receives from the civilian population.[12]

Fixing near-term problems often leads to kicking the can down the road on improving long-term projects. Despite knowledge and warning of growing USAF pilot shortages as early as the year 2000; 20 years later, the USAF is still in a pilot shortage crisis exacerbated by civilian sector opportunities.[13] The is also a problem with AMC's aging fleet of aircraft as the USAF continues to extend aircraft service life. The 70-year-old KC-135 AR airframe continues to operate as problems with fully operationalizing its KC-46 replacement continue. The C-5 service has been extended to 2040 after an engine

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[11] JCS, *Air Mobility Operations*, 87.

[12] Ben Piven, "US Military Spending: Many Americans Now Believe Less Is More" (Al Jazeera, 18 November 2019), https://www.aljazeera.com/ajimpact/military-spending-americans-191115231125662.html.

[13] William Taylor, S. Craig Moore and C. Robert Roll, Jr, "The Air Force Pilot Shortage: A Crisis for Operational Units," (Santa Monica: RAND, 2000), xi.

upgrade improved efficiency and reliability. [14] Despite talks of a CX program to implement the USAF's next heavy airlifter intended to replace the C-17 and C-130, history may indicate that similar operational delays will occur with a CX entrance to service.[15] With a long-term focus and investment in AI, many of these problems can be solved. Though AI is a decades old concept, the DoD and USAF have only in the last few years begun to implement its use.

CURRENT USAF AND AMC USES OF ARTIFICIAL INTELLIGENCE

The future of AI in the USAF and AMC will likely continue to focus on weak (or narrow) AI systems due to ethical dilemmas and the current inability for AI to discriminate between combatants and non-combatants. In Neopolitan and Jiang's describe strong (or general) AI in which "the appropriately programmed computer really is a mind, in the sense that computers given the right programs can be literally said to understand and have other cognitive states," and in contrast, weak AI is "the position that computers could appear and behave intelligently, but not necessarily understand."[16] In basic terms, the text states "the essence of the matter is whether a computer could actually have a mind (strong AI) or could only simulate a mind (weak AI)."[17] Professor of AI and Robotics, Noel Sharkey, cautions that "there is no sensing or computational capability that would allow a robot such a determination" between combatant and non-

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[14] Christopher Woody, "After 17 Years of Upgrades, the Air Force's Biggest Plane Is Ready to Stay in the Air for Decades," (Business Insider, 13 August 2018) https://www.businessinsider.com/air-force-c-5m-super-galaxy-upgrade-done-will-stay-in-air-until-2040s-2018-8.

[15] Kris Osborn, "Air Force Seeks Jets Beyond C-17 and Even JSF," Military.com, 17 December 2013, https://www.military.com/daily-news/2013/12/17/air-force-seeks-jets-beyond-c17-and-even-jsf.html.

[16] Richard E. Neapolitan and Xia Jiang, *Artificial Intelligence: with an Introduction to Machine Learning* (Boca Raton: CRC Press, an imprint of Taylor & Francis Group, 2018), 15.

[17] *Ibid.*

combatant.[18] Sharkey maintains the opinion that "a total global ban on the development of autonomous lethal targeting is the best moral course of action."[19] With similar concerns in mind, Chief of Staff of the Air Force (CSAF) David Goldfein highlighted that "adoption [of AI] must be thoughtfully considered in accordance with our ethical, moral, and legal obligations," and while implementing AI technology Airmen must understand "that everything we do is a human endeavor."[20]

In 2019, the USAF published a service specific annex to the Department of Defense's (DoD) 2018 AI strategy. Derived from the four focus areas of the DoD strategy, three of the focus areas address that the USAF cannot advance AI in a vacuum. The USAF must take advantage of commercial capabilities, utilize publicly available algorithms while also sharing its solutions "enterprise-wide," and also "increase transparency and cooperation with international, government, industry, and academic partners."[21] The remaining two focus areas, aim to incorporate AI into how the USAF personnel direct its personnel through recognition and treatment of "data as a strategic asset" and through action to "recruit, develop, upskill, and cultivate [the USAF] workforce" as it continues to integrate AI and other emerging technologies.[22] Because of the ethical and moral concerns with the use of robots and artificial intelligence, outside of policy and strategy, there are no disclosed lethal uses of automation in the USAF. Most

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[18] Noel E. Sharkey, "Grounds for Discrimination: Autonomous Robot Weapons," RUSI Defence Systems, Vol. 11, No. 2, (2008): 88.

[19] Noel E. Sharkey, "The Evitability of Autonomous Robot Warfare," International Review of the Red Cross, Vol. 94, No. 886 (Summer 2012): 799.

[20] Department of the Air Force, "Artificial Intelligence Annex to the Department of Defense Artificial Intelligence Strategy," (September 2019), 2, https://www.google.com/search?q=artificial+intelligence+annex+to+dod&rlz=1C1GCEA_enCA864CA864&oq=artificial+intelligence+annex+to+dod&aqs=chrome..69i57j33.5182j0j4&sourceid=chrome&ie=UTF-8#.

[21] *Ibid.*, 3-5.

[22] *Ibid.*, 3-4.

of the weak AI and autonomy in the USAF so far is mainly to enhance rather than replace the human in the loop.

The best example of automated aerial vehicles in use by the USAF is the RQ-4 Global Hawk. Like other remotely piloted aircraft (RPA), the RQ-4 still requires a crew for launch, mission execution, and recovery, however, once airborne, it "provides its own navigation, using GPS technology and internal inertial navigation [which] allows the aircraft to fly completely autonomously."[23] The more sophisticated automation of the RQ-4 is a benefit over the other RPAs like the Reaper and Predator which have demonstrated, during lost-link to human pilot control, the pitfall of unpredictable responses.[24] The use of AI in AMC remains outside of operations and primarily within the training realm.

During AMC's Flight Commander course in September of 2019, the training incorporated a leadership simulation driven by artificial intelligence to "give a more realistic practice to complex interpersonal skills" and challenging "students to be more attentive to aspects like body language or tone of voice of the individual."[25] With this being the first time AI has been used during the course, the capability to better train tomorrow's officers using AI is evident, as is the realization that the USAF has only begun to scratch the surface of areas for AI enhancement. The next two sections will highlight the areas AI can be implemented to solve Air Mobility Command's operations and training.

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[23] Paul J. Springer, *Military Robots and Drones: A Reference Handbook* (Santa Barbara, CA: ABC-CLIO, 2013), 126.

[24] *Ibid*.

[25] Ariel Owings, "First Ever: Artificial Intelligence Used for AMC Flight Commander Cour," Air Mobility Command, 2 October 2019, https://www.amc.af.mil/News/Article-Display/Article/1979729/first-ever-artificial-intelligence-used-for-amc-flight-commander-course/.

FUTURE ADAPTATION OF AI TO CORRECT USAF PROBLEMS

Pilot Shortage Crisis

Not isolated to the USAF, but across its sister services and in other countries' Air Forces, a shortage in pilots has begun to impact the capacity to execute flight operations and lower the morale of personnel. While there seemed to be a reverse in the trend at the end of 2018, short only 1,937 pilots compared to the previous year's shortage of 2,000 pilots, the end of 2019 reflected a larger "2,100 pilots short of the 21,000 needed to execute the National Defense Strategy."[26] Two potential uses of AI to reduce this pilot shortage would be through automated aerial vehicles (AAV) and pilot augmentation.

In the 2015 published Air Force Future Operating Concept (AFFOC), a glimpse into the 2035 Rapid Global Mobility mission "employs a *balanced capabilities mix* of manned, remotely operated, and autonomous assets to support operations in both contested and uncontested environments."[27] In 2035, the most likely use of autonomous systems in AMC would be for missions that did not involve moving humans. Only 17% of 8,000 respondents in a 2015 UBS survey "said they would be likely to take a pilotless flight."[28] Reserving autonomous systems for cargo and aerial refueling platforms is the probable scenario. However, with the new piloted KC-46, and the CX program intending

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[26] Oriana Pawlyk, "Military Daily News," Military.com, 5 March 2020, https://www.military.com/daily-news/2020/03/05/air-forces-pilot-shortage-got-worse-2019.htm). At the time of this paper, the COVID-19 Coronavirus pandemic has impacted global airline operations. Many countries have implemented travel bans which have greatly reduced airline travel. While it is too early to fully gauge the impact of COVID-19, the many former USAF Active Duty pilots whom have separated recently and are unable to quickly transition into the civilian sector may return to active duty, and Active Duty pilots that have submitted intent to separate may delay separation. This may reflect an artificial reversal in the pilot shortage trend at the end of 2020, possibly 2021 should COVID-19 continue to spread.

[27] Department of the Air Force, *Air Force Future Operating Concepts: A View of the Air Force in 2035*. (September 2015): 26, https://www.af.mil/Portals/1/images/airpower/AFFOC.pdf.

[28] Leslie Josephs, "Your Plane Could Fly Itself by 2025...If You're Cool with That," Quartz, 7 August 2017, https://qz.com/1047825/your-airplane-could-fly-itself-by-2025-if-youre-cool-with-that/.

to replace the less dated C-17) whose life cycle will most likely be extended past the 2040 C-5M life cycle), 2035 is most likely too early to have fully autonomous replacement in these missions. AI augmentation of pilots could be the bridge between manned and complete autonomy.

An "augmented" C-17 flight crew in AMC consists of three pilots, extending the standard 16-hour flight duty period to 24-hours.[29] The idea that two pilots flying and monitoring while the third is resting, and the pilots will rotate giving each a chance to rest. With autopilot technology, pilots have become primarily systems monitors for a majority of the flight. Key Dismukes, a former NASA human factors scientist, argues that "the human brain isn't very well designed to monitor for [emergencies]" due to its "natural tendency to sometimes see but disregard important information."[30] Not only are pilots unable to effectively process the data, there is an inconsistency among differing pilot monitoring techniques.[31]

Most modern aircraft systems automatically take mitigating action during emergencies, leaving the human pilot to perform any actions the computer was unable to make like the decision to continue the mission or return to base. The future of automation would do more than efficiently identify and rectify aircraft system issues. The system would also know and process all the potential options and quickly select the best course of action without emotion, allowing the onboard pilot or a human monitoring multiple aircraft from a ground facility to determine whether or not to intervene. As fidelity is

[29] Department of the Air Force, *C-17 Operations Procedures*, AFMAN 11-2C-17 Vol 3 (Scott Air Force Base: Air Mobility Command, 2019), 15.

[30] Joan Lowy and Associated Press, "Human Brain Not Wired to Steadily Monitor Automated Airline Cockpit Systems, Experts Say - Canadian Business," Canadian Business, 7 September 2013, https://www.canadianbusiness.com/business-news/consistently-monitoring-automated-cockpit-systems-sometimes-difficult-for-airline-pilots/.

[31] *Ibid.*

proven in using this system, replacing at least one of the three pilots would render more pilots available for other missions, driving down AMC airlift pilot requirements. The onboard pilot would still have to maintain competent flying abilities, driving a continued requirement for pilot training.

AI aided learning during pilot training could assist with further reducing the pilot shortage by reducing the length of time for a student that has never touched the yoke of an aircraft to flying in their assigned aircraft, increasing the competency of the new pilot on day one in the squadron, or a combination of both. Targeted Neuroplasticity Training (TNT) and brain-to-brain interfacing are among future training technologies that Robert Latiff describes in *Future War* and could be used to enhance pilot training.[32]

Defense Advanced Research Project Agency (DARPA) is currently researching TNT as a way to use "external stimulation, not of the brain, but of the peripheral nervous system . . . outside of the brain and spinal cord" in order to hasten cognitive skills.[33] Though Latiff specifically lists linguists, intelligence analysts, and cryptographers as military career fields that could be enhanced by TNT, the physical and mental coordination required to fly an aircraft makes it a perfect occupation that would benefit from this type of training. While TNT may reduce the time a pilot spends learning the basic skills of flying, they still lack the experience of the more senior pilots.

Brain-to-brain interfacing between two rats using microelectrodes by scientists at Duke University showed that brain activity simulated by visual cues given to one rat were transferred to another rat which did not receive a visual cue. During the trials, the second

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[32] Robert H. Latiff, *Future War: Preparing for the New Global Battlefield* (New York: Vintage Books, 2018), 21.

[33] *Ibid.,* 23.

rat was able to achieve "success rates significantly above chance."[34] Even more surprising is that a test to determine the range of transmission, in which brain signals derived from one rat in Brazil were then transmitted via the internet to another rat in North Carolina, "found that the two rats could still work together."[35] Though Latiff mentions that this technology is still in its infancy, one day brain activity that is captured from the most experienced pilot instructors could be transmitted to new pilot trainees. This has the potential to bridge the gap in experience between the pilot on the cusp of retirement and the new pilot standing on the threshold of their career.

Maintaining Aging Aircraft

The AFFOC describes technology of the future will be "systems and capabilities that are modular or configurable to allow rapid adaptation or upgrades" while ensuring engineering and design allows for smart, efficient, and cost-effective sustainment.[36] The future of aviation continues to use composite materials as they are lighter, stronger, and provide many advantages that traditional metal components lack. Composites do pose disadvantages in maintenance as long adopted aviation practices are incompatible with inspections and repairs.[37] These disadvantages are corrected with embedded sensors which allow for better predictive maintenance.[38] The USAF is moving toward predictive maintenance, however, current AMC maintenance relies on pilots manually passing aircraft status prior to arrival. A status requiring maintenance is unknown until an issue

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[34] Latiff, *Future War . . .*, 22.
[35] *Ibid.*
[36] Department of the Air Force, *Air Force Future Operating Concepts . . .*,. 42.
[37] Robert Yancey, "How Composites are Strengthening the Aviation Industry," Industry Week, June 11, 2012, https://www.industryweek.com/none/article/21957226/how-composites-are-strengthening-the-aviation-industry.
[38] *Ibid.*

has already occurred, and the information passed is often incomplete due to human errors discussed later in this paper.

In the distant future as aging aircraft are replaced, predictive maintenance technology replaces human transfer of information from direct link between embedded sensors and computers at the destination maintenance facility. The systems automatically track and intervene when maintenance is required prior to complete failure of aircraft components. In the near term, the Conditions Based Maintenance Plus (CBM+) program must expand beyond the few aircraft that the program currently covers. CBM+ utilizes sensors placed on existing aircraft to "gather data on when parts may break," and providing warning prior to component failures on C-5 and C-130 airlifters.[39] General Arnold Bunch, commander of Air Force Materiel Command, highlighted that senior leaders agreed "predictive maintenance is critical to . . .managing aging fleets."[40] A

General Bunch further mentioned "there is an investment we need to make on the front end to be able to reap those rewards" of predictive maintenance, but it would come at significant cost and its importance must be conveyed to obtain USAF buy in.[41] Fortunately, only three months after General Bunch's comments, the USAF published its AI strategy. It appears for now that the USAF has bought into the need for AI technology, but it will still require long term thinking by senior leaders to prioritize future needs at the sacrifice of funding fewer near-term problems.

[39] Rachel Cohen, "USAF Seeks New Strategy to Grow Predictive Maintenance Gains," Air Force Magazine, 24 June 2019, https://www.airforcemag.com/usaf-seeks-new-strategy-to-grow-predictive-maintenance-gains/.

[40] *Ibid.*

[41] *Ibid.*

FUTURE ADAPTATION OF AI TO IMPROVE AMC EFFICIENCY

Tanker Airlift Control Center Operations Monitoring

The 618th Air Operations Center, known in the mobility community as the Tanker Airlift Control Center (TACC), located in Illinois is the execution arm of AMC.[42] Every 2.9 minutes, AMC aircraft depart from airfields all over the world; this equates to over 450 flights per day, of which 200 receive command and control directly from TACC.[43] While many modern AMC aircraft are equipped with Aircraft Communications, Addressing and Reporting Systems (ACARS) that transmit data automatically to TACC for mission management awareness, the data is very rudimentary and is typically limited to takeoff and landing times, and location.[44]

Outside of ACARS, a majority of the information comes directly from the aircrew or is transmitted by base command post personnel if the AMC aircraft has landed at a military base. The human-to-human transactions are prone to error through omission of key data either by lack of technical knowledge and experience of the person delivering or receiving the information, an incorrect diagnosis if maintenance related, or fatigue from an aircrew at the end of a 24-hour augmented duty day. The aircraft commander (AC) is the direct node for TACC and the aircrew, and if located at an airfield without standard base support, acts as the node for all things related to the mission and the aircraft. If the crew is in the period of uninterrupted crew rest, TACC is unable to receive status updates for a minimum of 12 hours. There is a way to mitigate this update gap.

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[42] "About Us," 618 Air Operations Center, March 2019, https://www.618tacc.amc.af.mil/About-Us/.

[43] Jesenia Landaverde, "618th AOC Enables Team Fairchild Tanker Operations," Fairchild Air Force Base, 4 October 2019, https://www.fairchild.af.mil/News/Features/Display/Article/1981144/618th-aoc-enables-team-fairchild-tanker-operations/.

[44] "SKYbrary Wiki," Aircraft Communications, Addressing and Reporting System - SKYbrary Aviation Safety, accessed 1 April 2020, https://www.skybrary.aero/index.php/Aircraft_Communications,_Addressing_and_Reporting_System).

In addition to the real-time aircraft maintenance status automatically received from the ACARS ahead of aircraft arrival as mentioned in the previous section, once on the ground, there is software currently in existence that uses image recognition algorithms to analyze the airport video feed to determine the status of an aircraft.[45] The software recognizes through the video feed any objects, movements and interactions around the aircraft to determine what is being done to prepare the aircraft for the next flight.[46] This software relies on video feed taken from cameras that overlook commercial airlines parked at airport passenger terminals. AMC aircraft rarely park at passenger terminals, therefore, cameras enabled to transmit the data would have to be installed on the aircraft or setup upon arrival. Instead of relying on the AC for information, TACC could already have this data. Further into the future, with this data fed into a machine capable of managing missions while learning to develop more efficient TACC processes, a minimally staffed TACC would reduce the errors derived from human transactions. The possible downside to this technology would be that without a human buffer between senior leadership and the aircrew, there is the potential for micromanagement by AMC strategic leadership scrutinizing AC tactical decision-making.

With 200 managed missions per day, this technology removes elements of human error by providing all the data rather than just the information deemed critical by aircrew or command post personnel while providing an avenue to streamline aircrew operations. However, command and control is but one piece to the AMC enterprise. AI can also improve efficiency in the logistics of preparing cargo for air transit.

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[45] "AI and Data Science in Aviation Industry: 5 Real-life Use Cases," Youtube video, 9:20, posted by "AltexSoft," 29 January 2020, https://www.youtube.com/watch?v=D8NlYPtPgwA.

[46] *Ibid*.

Aerial Port Automation and Efficiency

The 2035 aerial port of the future is described as a senior enlisted member overseeing robots building pallets of supplies while other robots load cargo onto a C-130J.[47] This AFFOC scenario relies on "Big Data systems designed to specifically anticipate the logistics needs of fielded forces . . . [using] historical trends of the force and the enemy, and weather forecasts" to effectively package cargo and properly phase its delivery.[48] The scenario is intended to give a broad view of what the APotF will look like rather than capture everything that is making this future possible. What might be implied in this scenario is a massive cargo hangar with capacity to horde supplies, or a supply chain that is able to respond rapidly with little delay in order deliver supplies for immediate processing and shipment.

An alternative would be the use of additive manufacturing to produce larger items and the shipment of portable 3D printers and material to forward operating locations to manufacture smaller items. This could reduce the number of sorties required as well as reduce the time between the soldier identifying a need and having that need met. Shipping company UPS is turning "its airport hub warehouses into mini-factories. The idea is to produce and deliver customized parts to customers as needed, instead of devoting acres of shelving to vast inventories."[49] AI is already integrated within 3D printing for faster design generation and error detection.[50] The future of AI incorporates

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[47] Department of the Air Force, *Air Force Future Operating Concepts* . . ., 27.
[48] *Ibid*.
[49] Richard D'Aveni, "The 3-D Printing Revolution," Harvard Business Review, 16 November 2015, https://hbr.org/2015/05/the-3-d-printing-revolution.
[50] Venkat K, "Artificial Intelligence and 3D Printing: Future of Manufacturing," Medium, 25 October 2019, https://medium.com/@venkat34.k/artificial-intelligence-and-3d-printing-future-of-manufacturing-d84fb94b1c7d

robots and machine learning to create complex structures.[51] The aerial port Airman's exposure to hostilities in austere combat locations will no longer be required.

Airlift Operations into Austere Locations

Whether airlift is performed onto austere dirt strips in a combat zone or into an uncontrolled airfield due to hurricane damage, there is the potential that an aircrew must fly to a location that does not have current threat reporting, adequate airfield surface analysis, or working approach equipment and lighting to allow safe access. Autonomous systems can be used in the future to temporarily stand-in for absent or failed equipment.

Air Force chief scientist Greg Zacharias stated in 2016 that a C-130 launched autonomous air vehicle to penetrate clouds to assess the ground situation was being worked on by Air Force Special Forces.[52] Additionally, a DARPA project called "Gremlins" is a concept that includes "launching groups of unmanned aerial vehicles from large aircraft."[53] The use of an AAV launched from the cargo aircraft and flying ahead to assess the ground threat would supplement the information the crew received hours prior during their pre-departure intelligence briefing. Furthermore, once in the combat zone, swarms of AAVs could be used for terrain mapping and providing route waypoints for airlift aircraft performing terrain masking low-level missions. While not a replacement for adequate aircrew mission planning, the data would still enhance the aircrew's ability to avoid controlled flight into the terrain. For HADR flights onto dirt strips or damaged airfields, the AAVs could assess the runway surfaces as was done in

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[51] Venkat K, "Artificial Intelligence and 3D Printing: Future of Manufacturing," Medium, 25 October 2019, https://medium.com/@venkat34.k/artificial-intelligence-and-3d-printing-future-of-manufacturing-d84fb94b1c7d

[52] Phillip Swarts, "Air Force Looking at Autonomous Systems to Aid War Fighters," Air Force Times, 7 August 2017, https://www.airforcetimes.com/news/your-air-force/2016/05/17/air-force-looking-at-autonomous-systems-to-aid-war-fighters/.

[53] Latiff, *Future War . . .*, 28.

Operation Tomodachi. In poor weather conditions, these AAVs could also create ad hoc instrument approaches and provide approach lighting for the inbound cargo aircraft carrying teams to establish more permanent capabilities.

Barrier to Implementation

Though possibilities seem endless as the USAF and DoD continue to refine the AI strategy in the coming years, they must not discard the human element that thrust the DoD into this era of new technology. Using a combination of theoretical models for technology acceptance, Captain Williams studied the potential resistance and challenges of "[implementing] technological tools . . . to aid AMC Airmen in their [APotF] duties of transporting goods and personnel."[54] Williams' research concluded that if aerial port Airmen, whom these days are already technologically savvy, could not intuitively learn how to use the new technology or if the technology relied on network infrastructures that had not been upgraded to support the technology, willingness to implement the technology would be low.[55] Williams' final recommendation was to ensure "investments are on quality products, that are durable, with the highest performance for the money."[56]

As new technology is made available and commanders aim to meet the strategic guidance of incorporating AI into operations, they must not be too eager to prematurely force the technology on front-line personnel without ensuring supporting infrastructure are in place. The USAF must also ensure that in procurement, fiscal responsibility includes consideration to quality and not only cost.

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[54] Williams, "Aerial Port of the Future . . .", iv.
[55] *Ibid*., 50.
[56] *Ibid*.

SELF-INFLICTED THIRD OFFSET VULNERABILITIES

The DoD third offset strategy is a focus on innovation and refers to technology investment to ensure military superiority.[57] Lyons and Flourney indicate that "powers like China and Russia are investing heavily in new technologies and military capabilities specifically designed to blunt U.S. strengths and exploit U.S. vulnerabilities."[58] As the USAF adds more AI and autonomous systems into its repertoire of capabilities, it must acknowledge without hubris the "reality that peer or near-peer nations will also employ high-tech systems against us."[59] There is no doubt which foreign countries pose the greatest future threat. However, one must also consider that the DoD's greatest future threat is itself. These threats include the western approach to morals and ethics with the use of AI as well as the race for maintaining that third offset leading to over reliance on systems without the proper understanding of how they work.

The moral and ethical dilemmas that the U.S. faces with implementing AI is not wholly shared by Russia and China, whose use in AI has shown to have "fewer scruples and controls than western states."[60] This dilemma puts the U.S. at a disadvantage in an AI arms race and at the rate that China has shown to produce research papers in advanced technologies ponders one to ask if AMC can sustain its mission against an adversary that denies the ability to use the technology mentioned in this paper? Though the DoD policy has shown resistance toward full autonomy and aims for technology that enhances the

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[57] Michele A. Flourney and Robert P. Lyons III, "Sustaining and Enhancing the U.S. Military's Technology Edge," Strategic Studies Quarterly, Vol 10, No 2 (Summer 2016): 5, https://www.jstor.org/stable/pdf/26271502.

[58] *Ibid*., 3.

[59] Latiff, *Future War*, 15.

[60] Peter Apps, "Amid Ethical Fears, China and Russia Ahead in AI Arms Race," Irish Examiner, 16 January 2019, https://www.irishexaminer.com/breakingnews/views/analysis/amid-ethical-fears-china-and-russia-ahead-in-ai-arms-race-897836.html.

human ability to perform, it assumes that the third offset is maintained by humans using AI. If that third offset fails, it may force the DoD to adopt an AI policy that forces blind trust and over reliance on autonomous systems.

Deputy Editor for Breaking Defense raises the point that with AI, “alien minds produce alien solutions.” He expresses the concern that AI develops effective solutions and strategies that humans would never conceive nor be able to execute due to complexity or lack of ability to understand.[61] Failure of APotF autonomous equipment that “automatically positions and prioritizes pallets for airlift missions” and reduces the time to process and load cargo by 70% is detrimental. Currently, personnel are ready and capable to step in and replace the automation should it fail. But, as these systems become more complex and utilize strategies that are foreign to the human, the response my not be as quick if even possible. Amazon warehouses utilize a “random stow” strategy which “makes sense when there’s limited space, or when the timing or quantity of inventory is unpredictable.”[62] While traditional aerial ports are not often limited by space, timing and quantity of demand is often unpredictable when at the whim of global events. The reliance on a robotic solution utilizing efficient random methods would create confusion and debilitate the aerial port personnel’s response during system failure. The personnel whose skills have atrophied are now operating in a dangerous environment where risks had been mitigated by machine. As the implementation of machines reduce risk to human life, the appetite for risk has atrophied as well.

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[61] Sydney J Freedberg, “How AI Could Change The Art Of War,” Breaking Defense, 25 April 2019, https://breakingdefense.com/2019/04/how-ai-could-change-the-art-of-war/.

[62] Sarah Kessler, “Amazon Built One of the World's Most Efficient Warehouses by Embracing Chaos” (Quartz, 21 February 2018), https://classic.qz.com/perfect-company-2/1172282/this-company-built-one-of-the-worlds-most-efficient-warehouses-by-embracing-chaos/.

The final concern is that an offset strategy "is consciously designed to diminish or balance adversaries' known advantages with asymmetric alternatives."[63] Contrast to the first two offset strategies created during the Cold War era, this offset strategy must work in a world that is highly globalized and interconnected. In the case of space operations, maintaining asymmetric advantages requires acceptance among nations and the standstill of recent international negotiations on activities in outer space was due to disagreements on the inherent right of self-defense.[64] During a time that world views of the United States are on shaky ground, it will be imperative that use of AI as part of a third offset strategy, whether or not for aggressive activities, is accepted on the world stage.

CONCLUSION

Implementation of AI systems are showing promise in today's Air Mobility Command as seen through the leadership training conducted by AMC's flight commanders. As the USAF incorporates methods being researched today, the future of training in the USAF and AMC will seek to use AI to rid the AF of its current issues with pilot shortages, maintenance of aging fleets, and inconsistent command and control. Armed with a directed focus on AI from the USAF's published Future Operating Concepts and 2019 AI strategy, tomorrow's airmen will be better trained and prepared for war because of AI enhanced and augmented training. However, success in the third-offset strategy by maintaining the asymmetric technological edge is challenged by the rise in capabilities of near-peer adversaries, but our fear of the adversary may drive technological advantage to a point that humans are unable to replace absence of machine.

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[63] James Hasik, "Beyond the Third Offset," Joint Forces Quarterly, 4th Quarter (2018): 15, https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-91/jfq-91_14-21_Hasik.pdf.

[64] Cassandra Steer, "Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space," Georgetown Journal of International Affairs 18, 1 (Winter/Spring 2017): 10.

Haste in replacing the human completely must be avoided to ensure AMC does not become a lame duck should vulnerabilities in AI be successfully exploited. The USAF will have to ensure that its policies continue to place priority on the human element, and lest the U.S. adopt similar ethical approaches as its adversaries, it will have to rely on cooperation with allies and international support to bridge the vulnerability should the third-offset strategy fail.

Human capital and committed investment in AI technologies are the only way that AMC can effectively fight the next war. Air Force Airmen will always control the yoke, but AI must advance the throttles.

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