# C1: Bubble

**The AI bubble is popping right now -- long term profits are the only solution,**

Ian **Krietzberg**, 4-17-20**24**, "Here's how investors should navigate the bubble of the AI boom," TheStreet, https://www.thestreet.com/technology/heres-how-investors-should-navigate-the-bubble-of-the-ai-boom, accessed 2-23-2025 //sgubbi

Here's how investors should navigate the bubble of the AI boom **One leading venture capitalist told TheStreet that when the hysteria ends, AI companies will need to start making money. How they might do so is a 'terrifying' question.** Fast Facts **AI hype has pushed tech valuations into the stratosphere over the past year in the early stages of what some have deemed the 'AI bubble.'** TheStreet sat down with Ari Newman, co-founder of venture capital firm Massive, to discuss his AI investment strategy in the midst of AI washing and investor hysteria. **He said that eventually, AI companies will have to start making money. How they might do so is a 'terrifying' prospect to consider.** A veritable tsunami of hype around artificial intelligence has spent the past year pushing the valuations of both private and public tech firms ever higher. Shares of Nvidia undefined, the AI chipmaker that has been deemed the "picks and shovels of the AI gold rush," have more than tripled since this time last year. Microsoft (MSFT) , all on the back of investor excitement around its explorations in AI, has added about $1 trillion to its market cap over the past year. And that's just two of the leading publicly traded AI firms. **Soap Bubbles in front of the New York Stock Exchange (NYSE) symbolize the potential Danger of a new Bubble evolving in the** **Financial Markets Researcher** has a **warning about the future of the AI boom** AI startups have also been absorbing funds at a quick rate; The Information reported Tuesday that French startup Mistral is in talks to raise funds at a $5 billion valuation. This comes just a few months after the company raised $415 million at a $2 billion valuation in December. OpenAI, the Microsoft-funded startup behind ChatGPT, has a valuation of around $80 billion. Anthropic is valued at around $18 billion. In 2023, $50 billion of venture capital made its way to AI startups, according to Cruncbase data, a significant slice of the $285 billion that was invested in startups last year. Google, according to Bloomberg, plans to invest more than $100 billion "over time" in AI. And Goldman Sachs CEO David Solomon said on Monday's earnings call that the opportunity for AI investment represents a "level of scale that is candidly unprecedented." But even **as valuations** continue to **soar**, the **cracks are** beginning to become more **obvious**. Venture capital firm Sequoia recently found that in 2023, AI firms collectively spent $50 billion on Nvidia chips alone. They brought in only $3 billion in revenue. A recent survey conducted by PagerDuty found that the vast majority of executives have security concerns related to AI, and have paused internal AI initiatives until these concerns can be resolved. AI researcher and cognitive scientist Gary Marcus has said that the industry is dealing with a simple, core problem: hallucinations — when an AI model confidently generates false information — make models unreliable; that unreliability makes them non-viable for corporate use-cases, which results in an enormously expensive software that can't seem to generate much in the way of revenue. Ari Newman, co-founder and managing director of venture capital firm Massive, likewise thinks that "we're in a bubble." The challenge, he said, is figuring out where in the bubble we are, and how to identify sources of value that might survive a burst. VC says the AI bubble is here "**We could** very well **be in the very beginning**" **of a bubble**, Newman told TheStreet, adding that it might be "a bubble on top of a bubble." The reason he thinks it will burst eventually comes from his understanding of the cryptocurrency and dot-com bubbles. "Part of what drives the bubble is various players in that ecosystem becoming each other's customers. We had banks, we had chains, we had exchanges, we had service providers, marketing firms ... the entire ecosystem was propping itself up," he said. "We're going to run into the exact same thing" with AI. At some point, Newman said, these companies that have gained such enormous valuations will need to figure out how to turn a profit.

**Luckily, this crisis has been averted by rapid growth of AI in education**

**World Economic Forum**, 1-9-20**25**, "Using AI in education to help teachers and their students," https://www.weforum.org/stories/2025/01/how-ai-and-human-teachers-can-collaborate-to-transform-education/, accessed 2-23-2025 // SnowyGremlin

As artificial intelligence (AI) reshapes industries worldwide, the classroom presents a unique opportunity – not to replace human teachers, but to enhance their capabilities in unprecedented ways. This transformation is already underway: The global AI in education market is expected to grow from $5.18 billion in 2024 to $112.3 billion by 2034. While many headlines have highlighted AI’s potential to automate educational tasks, the more compelling narrative lies in how teachers can work with AI to craft transformative learning experiences. From adaptive learning platforms that personalize content for millions of students, to AI assistants that help teachers work more efficiently, the future of education isn’t about choosing between human teachers and AI, but rather harnessing the best of both worlds.

**Popping of the bubble causes recession**

Daniel **Liberto**, 12-1-20**22**, "How Do Asset Bubbles Cause Recessions?," Investopedia, https://www.investopedia.com/articles/investing/082515/how-do-asset-bubbles-cause-recessions.asp, accessed 2-23-2025 //DCV-JWV

This redistribution of wealth and income from late investors to the early recipients of newly created money and credit who got in on the ground floor is what makesthe formation and collapse of asset pricebubbles very much like a pyramid or Ponzi scheme. When this process is driven by money in its modern form of a fiat currency mostly made of fractional reserve credit created by the central bank and the banking system, then the bursting of the bubble not only induces losses to thethen-currentholders of the bubble assets,but it also can lead to a process of debt deflation that spreads beyond those exposed directly to the bubble assets to all other debtors as well. This means that any sufficiently large bubble can crash the entire economy into recession under the right monetary conditions.

**Causes poverty**

**Alexander**, D., 1-27-20**10**, "The Impact of the Economic Crisis on the World’s Poorest Countries," Wiley Online Library,

https://onlinelibrary.wiley.com/doi/full/10.1111/j.1758-5899.2009.00018.x, accessed 10-31-2023//IB

**Yet the impact of falling trade has also reached Africa. Twelve African countries receive over 75 per cent of their export earnings from nonfuel commodities.** Year on year, the International Monetary Fund’s (IMF’s) index of nonfuel commodity prices has fallen by 23 per cent**from 2008 to 2009**– with real impact on employment prospects across Africa.**The global recession has hit an important form of income for the poorest families – remittances. Globally worth over $300 billion a year, remittances are significantly larger than global aid flows.** Because 80 per cent of remittances to developing countries come from high-income countries, this source of income is vulnerable to economic crises – and indeed is expected to have fallen by between $25 billion and $66 billion over 2009 (Cali and Dell’Erba, 2009)**. This collapse in economic activity – from investment to trade and remittances – has turned the financial crisis into a social crisis.** For the poorest people in the least developed countries, this comes shortly after the rise in food prices in 2008 that **is estimated to** have pushed between 130 and 155 million people into poverty (World Bank, 2008)**. The United Nations has estimated that the worldwide recession has pushed 100 million more people below the poverty line (UN, 2009). That could set back progress towards meeting the first of the Millennium Development Goals – to halve extreme poverty – by up to three years (Alexander, 2008).** This collapse in economic activity – from investment to trade and remittances – has turned the financial crisis into a social crisis. Many more families are now being faced with the toughest decisions of extreme poverty: pulling children out of school to help provide for the family; forgoing medicines; and even choosing which of their children to feed. Indeed lives are threatened – infant mortality rates are set to rise by an additional 200,000 to 400,000 deaths each year from now to 2015 if the crisis continues (UN, 2009).

# C2: Pandemics

#### **New pandemics are coming in 2025---a host of factors prove.**

**Smith ’25** [Cecelia Smith-Schoenwalder; January 2nd; Senior Writer covering space, science and the environment for U.S. News & World Report; citing Dr. Perry N. Halkitis; Dean, Hunterdon Professor of Public Health & Health Equity, and Distinguished Professor of Biostatistics and Epidemiology at the Rutgers School of Public Health, Ph.D. in Quantitative Methods in Educational and Psychological Research from the City University of New York, M.S. in Education/Human Development and Learning from City University of New York, MPH in Epidemiology from the City University of New York; “5 Infectious Diseases to Keep an Eye On in 2025”; US News & World Report; https://www.usnews.com/news/health-news/articles/2025-01-02/5-infectious-diseases-to-keep-an-eye-on-in-2025] cameron

The new year is **certain** to bring the spread of infectious **diseases** – both **new** and **old**. And **several factors** make **2025** **ripe** for **transmission** in the U.S., including **declining** childhood **vaccination rates** and a potential **new leader** of the **H**ealth and **H**uman **S**ervices Department who appears ready to sow fresh doubt on vaccines in the next Trump administration.

U.S. health policy is likely to face close scrutiny over the next four years, particularly if Robert F. Kennedy Jr. gains Senate confirmation to lead HHS.

Kennedy, who denies being “anti-vaccine,” has long promoted **false conspiracy theories** about **vaccines**. He said in July that “there’s no vaccine that is, you know, safe and effective.”

While Kennedy has said he won’t ban vaccines – he likely wouldn’t have the authority, and any effort in that direction would prompt immediate legal challenges – he can still use his potential platform to **discredit** and **plant suspicions** about the **shots**, which can **affect** vaccine **uptake**. If confirmed, he would take over HHS at a time when childhood vaccination rates are declining and school vaccination requirement exemptions are on the rise. And at the same time, these pools of unvaccinated and undervaccinated children **create conditions** that **allow** infectious diseases to **spread**.

“The **outlook** for infectious diseases over the course of the next four years is a little **dismal**,” says Dr. Perry N. Halkitis, the dean of the Rutgers School of Public Health, breaking it down into three categories to watch: Reemerging, currently spreading and new infectious diseases.

#### **It’s overdue**

#### Sally **Davies** (20**20**, September 26). Sally Davies is a former chief medical officer for England, The next pandemic is on its way. Coronavirus must help us prepare. The Guardian. Retrieved on July 11, 2024 from [https://www.theguardian.com/commentisfree/2020/sep/26/next-pandemic-coronavirus-prepare] Zayn

#### **We are at a crossroads.** As the impacts of Covid-19 continue the world over and the second wave [moves through Europe](https://www.theguardian.com/world/2020/sep/25/france-covid-cases-hit-record-high-as-anger-grows-over-restrictions), we have a choice to make. Will we simply respond to the here and now, or do we take a moment to stop, look up and see beyond the horizon of this pandemic towards the next one? Because there will be a next one. **Covid-19** is neither the **first** nor the **last** health emergency we will face. My fellow **scientists estimate that we will face a pandemic** or health emergency **at least once every five years from here on**. There is a chance that this is the optimistic scenario. The reality could be far worse. Recognising this, we can, and must, say “never again”. We must do better to identify the next health threat, respond to that threat before it becomes an epidemic or pandemic, and if it does, recover in a way that does not exacerbate health, economic and social inequalities.

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#### **But, GenAI in medical education will enable doctors to contain them.**

Ravi **Janumpally 25**, 01-10-2025; Graduate Cum Laude. Completed core rotations in internal medicine, pediatrics, surgery, obstretics and gynecology and family medicine; “Generative artificial intelligence in graduate medical education” https://pmc.ncbi.nlm.nih.gov/articles/PMC11758457/] shua

**Generative artificial intelligence (GenAI) is rapidly transforming various sectors, including healthcare and education**. This paper explores the potential opportunities and risks of GenAI in graduate medical education (GME). **We review the existing literature and provide commentary on how GenAI could impact GME, including five key areas of opportunity: electronic health record (EHR) workload reduction, clinical simulation, individualized education, research and analytics support, and clinical decision support.** We then discuss significant risks, including inaccuracy and overreliance on AI-generated content, challenges to authenticity and academic integrity, potential biases in AI outputs, and privacy concerns. As GenAI technology matures, it will likely come to have an important role in the future of GME, but its integration should be guided by a thorough understanding of both its benefits and limitations. Introduction: Generative artificial intelligence (GenAI) is a relatively new technology that uses advanced machine learning models to generate human-like expression. Large language models (LLMs) like ChatGPT (OpenAI, San Francisco, United States) rely on a machine learning architecture called a “transformer.” A key feature of transformers is their self-attention mechanism, which allows the model to assess the importance of words in a sequence relative to one another, enhancing its ability to understand context and, when trained on vast amounts of data, resulting in a remarkable ability to understand and generate humanlike text (1). **Such models excel at tasks like document summarization, sentiment analysis, question answering, text classification, translation, text generation, and as conversational chatbots**. Related models called large vision models (LVMs), Vision-Language Models (VLMs), large multimodal models (LMMs), diffusion models, and generative adversarial networks (GANs) provide similar or overlapping functionality for image, audio, and video processing and generation. It is widely believed that GenAI will have far-reaching societal impact and will be incorporated into multiple aspects of our daily lives (2, 3). GenAI has the potential to revolutionize multiple industries, with healthcare and education among the likely targets. **In healthcare, GenAI has shown promise in a broad range of applications such as clinical decision support, medical education, clinical documentation, research support, and as a communication tool (4).** GenAI models like ChatGPT, even without special fine-tuning for medical knowledge, achieve performance at or near the passing threshold on all three United States Medical Licensing Examination (USMLE) Step exams (5). Studies evaluating performance on medical specialty board examination-or in-service examination-level questions have shown mixed results, but in some cases LLM performance has approached that of senior medical trainees (6–9). GenAI-powered tools are deployed in production clinical environments today, most notably in the patient care-adjacent domains of clinical documentation (10) and provider-patient communication, where they have shown promise in improving EHR-related provider inefficiency and burnout (11, 12). **In the medical educational setting, GenAI potentially offers multiple benefits such as easy personalization of learning experiences, simulation of real-world scenarios and patient interactions, and practicing communication skills (13).** These potential gains are balanced by meaningful risks, such as the trustworthiness of AI-generated content, the deepening of socioeconomic inequalities, and challenges to academic integrity (14, 15). Graduate medical education (GME) shares many characteristics with undergraduate medical education and with other types of healthcare education. As adult learners, medical trainees are theorized to learn best when self-motivated, self-directed, and engaged with task-centered, practical topics (16). Historically, medical education used time spent in the training environment as a proxy for learning success. More recently, there has been renewed interest in competency-based medical education (CBME), a paradigm that uses achievement of specific competencies rather that time spent (or other structural measures) as the key measure of learning success (17, 18). CBME serves as the foundation of the Accreditation Council for Graduate Medical Education (ACGME)’s accreditation model, and is the key theory underpinning the formative “Milestones” used by ACGME-accredited programs to assess trainee development and to improve education (19). Having built a foundation in medical sciences and basic clinical skills in medical school, GME trainees spend little time in the classroom, with most of their learning occurring with real patients as they function as members of the healthcare team. A core tenet of GME is “graded authority and responsibility,” where trainees progressively gain autonomy until they achieve the skills to practice independently. Additionally, trainees are expected to become “physician scholars”; participants in ACGME-accredited GME programs participate in scholarly pursuits like research, academic writing, quality improvement, and creation of educational curricula (20). In this paper, we present concise summary of the existing literature (Table 1) and commentary on the potential opportunities and risks of GenAI in the GME setting. 2.1 EHR workload reduction: Given their long work hours and stressful work environment, GME trainees are particularly susceptible to burnout, with rates higher than their age-matched peers in non-medical careers and higher than early-career attending physicians (21). Burnout among the academic physicians who comprise most GME faculty also occurs, and may impact the quality of training they are able to deliver (22, 23). Thus, innovations that prevent overwork and burnout have the potential to benefit GME trainees and faculty. One unintended consequence of the adoption of electronic health records (EHRs) has been a dramatic increase in time spent in documenting clinical encounters. Many physicians now spend as much time documenting in the EHR as they do in patient-facing activities (24). This documentation burden can result in medical errors, threats to patient safety, poor quality documentation, and attrition, and is a major cause of physician burnout (25). **Various strategies have been tried to reduce physician documentation burden, including medical scribes and various educational interventions, workflow improvements, and other strategies (26).** Given its ability to summarize, translate and generate text, GenAI demonstrates clear potential as a technological aid to alleviate the burden of clinical documentation. **The most notable current application is ambient listening tools that use GenAI to transcribe and analyze patient-doctor conversations, converting them into structured draft clinical notes that the physician would theoretically only then need to review for accuracy.** Numerous organizations are piloting such technology as of the time of this writing (27), though the few results published so far about real-world performance have been mixed (10, 28, 29). Examples of other less commercially mature concepts for how GenAI could reduce clinical documentation burden include tools to improve medical coding accuracy (30), to generate clinical summary documentation like discharge summaries (31), and to draft GME faculty supervisory notes (32). In addition to documenting clinical encounters, physicians (including GME trainees) spend large amounts of time in the EHR managing inbox messages, including patient messages, information about tests results, requests for refills, requests to sign clinical orders, and various administrative messages (33). As another major contributor to workload, EHR inbox management is also a cause of burnout (34, 35). This problem came to be of particular importance during the COVID-19 pandemic, where patient messaging increased by 157% compared to pre-pandemic levels (35). LLMs have shown the ability to draft high-quality, “empathetic” responses to patient questions (36). Early efforts to use LLMs for drafting replies to patient inbox messages have shown promising results, with multiple studies showing that LLMs can draft responses of good quality (37, 38) and at least one study showing good provider adoption with significant reductions in provider assessment of multiple burnout-related metrics (11). Multiple health information technology companies, including the largest United States EHR vendor, have already brought GenAI functionality for EHR inbox management to market (39–41). 2.2 Clinical Simulation: Simulation-based medical education (SBME) has evolved significantly since the early use of mannequins for basic life support training 60 years ago, and simulation using high-fidelity mannequins and virtual and augmented reality tools are now a vital component of GME. **There is a substantial body of evidence confirming the benefits of simulation-based training and the successful transfer of these skills to real patients (42, 43).** Simulations are used both to educate and to assess performance in GME. For example, the American Board of Anesthesiology incorporates an Objective Structured Clinical Examination (OSCE) meant to assess communication and professionalism, as well as technical skills, into the board examination process for anesthesiology residents (44). Many of the current applications of SBME in GME are targeted at procedural skills like complex surgical techniques, bridging the gap for trainees’ experiential learning on invasive, uncommon, or high-acuity procedures (45). **The integration of artificial intelligence into clinical simulations would theoretically allow for the customization of scenarios based on a trainee’s skill level and performance data, providing a personalized learning experience and potentially opening the door to new types of patient simulation** (43). Accordingly, there has been interest in using conversational GenAI to simulate patient encounters to practice cognitive and communication skills, though this application is more often focused on undergraduate medical education (15, 33, 46–49). **Among the most interesting potential applications of GenAI in GME is the concept of using synthetic data as training material for visual diagnosis**. GANs and diffusion models have shown promise in generating realistic images of pathology findings (50, 51), skin lesions (52–54), chest X-rays (55), genetic syndromes (56), and ophthalmological conditions (57). **The synthetic data approach may ultimately address important limitations in image-based training data sets, such as underrepresentation of certain patient demographics and adequate demonstration of rare findings**.

#### **Simulations have the potential key to solve ALL future pandemics.**

Karen **Reddin 21**, 04-05-2021; BSc Microbiology, PhD Microbiology, MSc Resilience; “Evaluating simulations as preparation for health crises like CoVID-19: Insights on incorporating simulation exercises for effective response” Pubmed, https://pmc.ncbi.nlm.nih.gov/articles/PMC8020603/] shua

**The research concluded that the use of a computer-simulation was effective in providing a facilitated environment for determining the perception of preparedness, evaluating general preparedness concepts and introduced participants to critical decisions involved in handling a regional pandemic influenza surge**. The design and use of simulations like this eliminate geography as a limitation to education delivery and can be applied at operational, tactical and strategic levels across many different sectors in addition to health. **Furthermore, it can also enhance the development of principles and governance tools that can support the development of an effective pandemic preparedness and response strategy [31]. The COVID-19 pandemic has also provided an opportunity to test in situ simulation in a clinical context using virtual application of clinical training for clinical procedures required during the pandemic**. A video-recorded simulation with virtual distribution was used to aid in the development of protocols for personal protective equipment (PPE) and Intensive Care practises. This enabled staff input and education under the constraints and pressures of a global pandemic [32]. Li et al. [33] also looked at the challenges and possible solutions for simulation and technology-enhanced learning during the COVID-19 outbreak in China and argue that after identifying the need for training, **simulation has become a powerful weapon fighting against the virus with respect to providing operational training for front line healthcare staff** as it can not only ensure patient safety but also provide a safe learning and training environment for HCWs to develop practical skills to deal with COVID-19. **They propose the development of simulation curricula to ensure better preparedness of HCWs for this and future pandemics**. This approach could be incorporated into a pandemic preparedness framework such as the WHO's EPPP framework used in this article.

**Mitigation is key**

Bill **Gates**, (William Henry Gates III is an American businessman and philanthropist who co-founded Microsoft with Paul Allen. Gates is known for his business strategies, technological innovation, and aggressive tactics that helped build Microsoft into the world's largest software company. He held various positions at Microsoft, including CEO, chairman, president, and chief software architect. ) 4/30/20**22**, Let’s make this the last pandemic, https://www.gatesnotes.com/Lets-make-this-the-last-pandemic)// JZ

**The great epidemiologist Larry Brilliant once said that “outbreaks are inevitable, but pandemics are optional.”** I thought about this quote and what it reveals about the COVID-19 pandemic often while I was working on my new book. On the one hand, it’s disheartening to imagine how **much loss and suffering could’ve been avoided if we’d only made better choices.** We are now more than two years into the pandemic. The world did not prioritize global health until it was too late, and the result has been catastrophic. Countries failed to prepare for pandemics, rich countries reduced funding for R&D, and most governments failed to strengthen their health systems. Although we’re finally reaching the light at the end of the tunnel, COVID still kills several thousand people every day. On the other hand, Dr. Brilliant’s quote makes me feel hopeful. **No one wants to live through this again—and we don’t have to. Outbreaks are inevitable, but pandemics are optional. The world doesn’t need to live in fear of the next pandemic. If we make key investments that benefit everyone, COVID-19 could be the last pandemic ever.** This idea is what my book, How to Prevent the Next Pandemic , is all about. I’ve been part of the effort to stop COVID since the early days of the outbreak, working together with experts from inside and out of the Gates Foundation who have been fighting infectious diseases for decades. I’m excited to share what I've learned along the way, because our experience with COVID gives us a clear pathway for how to be ready next time. So, how do we do it? In my book, I explain the steps we need to take to get ready. Together, they add up to a plan for eliminating the pandemic as a threat to humanity. These steps—alongside the remarkable progress we’ve already made over the last two years in creating new tools and understanding infectious diseases—will reduce the chance that anyone has to live through another COVID. Imagine a scenario like this: A concerning outbreak is rapidly identified by local public health agencies, which function effectively in even the world’s poorest countries. Anything out of the ordinary is shared with scientists for study, and the information is uploaded to a global database monitored by a dedicated team. If a threat is detected, governments sound the alarm and initiate public recommendations for travel, social distancing, and emergency planning. They start using the blunt tools that are already on hand, such as quarantines, antivirals that protect against almost any strain, and tests that can be performed anywhere. If this isn’t sufficient, then the world’s innovators immediately get to work developing new tests, treatments, and vaccines. Diagnostics in particular ramp up extremely fast so that large numbers of people can be tested in a short time. New drugs and vaccines are approved quickly, because we’ve agreed ahead of time on how to run trials safely and share the results. Once they’re ready to go into production, manufacturing gears up right away because factories are already in place and approved. No one gets left behind, because we’ve already worked out how to rapidly make enough vaccines for everyone. Everything gets where it’s supposed to, when it’s supposed to, because we’ve set up systems to get products delivered all the way to the patient. Communications about the situation are clear and avoid panic. And this all happens quickly. **The goal is to contain outbreaks within the first 100 days before they ever have the chance to spread around the world. If we had stopped the COVID pandemic before 100 days, we could’ve saved over 98 percent of the lives lost.** I hope people who read the book come away with a sense that ending the threat of pandemics forever is a realistic, achievable, and essential goal. I believe this is something that everyone—whether you’re an epidemiologist, a policymaker, or just someone who’s exhausted from the last two years–should care about.

**That’s key**

**Business Standard**, (Business Standard is an Indian English-language daily edition newspaper published by Business Standard Private Limited, also available in Hindi.) 8-11-20**24**, "Disease X could be next big pandemic, kill 50 million people, says expert," https://www.business-standard.com/world-news/disease-x-could-be-next-big-pandemic-kill-50-million-people-says-expert-123092600965\_1.html, accessed 8-11-2024

According to a UK health expert, **Disease X could lead to another pandemic more lethal than Covid-19 and could claim at least 50 million lives,** the Daily Mail reported. Earlier, the World Health Organization (WHO) stated that **Disease X represents an epidemic that could be caused by a pathogen currently unknown to cause human disease.**

# C3: Aviation

**Pilot shortages are running rampant.**

**Tirpak 25** [John Tirpak, 1-23-2025, "New Report: Fixes to Pilot ‘Crisis’ Tied to Fleet Size, Flying Hours, Reserves," Air & Space Forces Magazine, https://www.airandspaceforces.com/new-report-combat-pilot-crisis/, DOA: 3-5-2025] shaan

Fixing the Air Force’s chronic combat pilot shortage will require more aircraft in the **fleet**, more flying hours to squadron operations, and retaining more pilots within Reserve components, according to a new paper from AFA’s Mitchell Institute for Aerospace Studies.

“If we don’t have experienced fighter pilots, we risk the outcome not just of the mission, but the entire operation, or even the war,” said Heather Penney, senior resident fellow at Mitchell and author of the report.

Experience is particularly important for the pilot shortage given the time it takes to develop a seasoned pilot and the urgency of **g**reat **p**ower **c**ompetition.

At a virtual rollout to discuss the paper, Penney noted that it takes 250 flying hours and 60 simulator sorties to “grow” a qualified F-35 flight leader, and that pilot has already had more than a year of basic flight instruction. All told, it takes five years to train a combat pilot.

“But we can’t wait five years,” she said. “We must build the ‘fight tonight’ force with enough strategic depth to successfully sustain combat operations. … We are out of time, and we must have a sense of urgency, because if we don’t, we risk losing.”

The combat pilot shortfall has persisted and grown for more than 20 years. In 2006, the Air Force was short 200 fighter pilots, Penney said. That deficit grew to 1,000 fighter pilots by 2017 and now stands at 1,150 fighter pilots.

Those missing pilots mean there are fewer instructors available in frontline squadrons to help mature new aviators, and fewer experienced combat advisors that can be detailed to the staffs of combatant commanders, further degrading the overall force’s **capability**. Many studies have shown that more experienced pilots have a far better survival rate in combat, meaning less attrition in wartime of aviators and aircraft, Penney noted.

A major part of the Air Force’s problem, she said, is that there are not enough aircraft available for combat pilots to train on. Simulators are helpful and allow rehearsals of techniques that the Air Force doesn’t want to expose in open flight, but there also aren’t enough simulators to provide the necessary experience, and they are not yet good enough to season pilots in the basics of operating around airfields, in weather, and in dealing with the unexpected.

The Air Force is seeing low numbers in its Ready Aircrew Program, which gauges whether a squadron is qualified to go to war, she said. The RAP looks at on numbers of pilots in a squadron, the ratio of experienced to inexperienced pilots, the number of simulators available, and the number of flying hours and sorties the unit can generate per month. Fewer experienced pilots and less of everything else mean delays in upgrading junior aviators.

Retired Lt. Gen. Joseph Guastella, former deputy chief of staff for operations, said he is worried that the U.S. is losing its long-standing advantages of **superior** aircraft and more experienced pilots.

**That undermines Air Force effectiveness, enhanced training is key.**

**Jenkins et al. 22** [Phillip R. Jenkins, William N. Caballero, and Raymond R. Hill, 2-xx-2022, Dr. Phillip R. Jenkins is an Assistant Professor of Operations Research in the Department of Operational Sciences at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. "Predicting success in United States Air Force pilot training using machine learning techniques," No Publication, https://www.sciencedirect.com/science/article/abs/pii/S0038012121001130, DOA: 3-3-2025] shaan

\*Free link: https://sci-hub.ru/https://www.sciencedirect.com/science/article/abs/pii/S0038012121001130

\*SUPT: Specialized Undergraduate Pilot Training

United States Air Force (USAF) senior leaders have repeatedly expressed concerns about the service’s pilot shortage. In 2017, then Secretary of the Air Force (SECAF), Heather Wilson, disclosed that the military branch was 2,000 pilots below sustainable manning levels. She further stated that this shortfall was poised to “break the force” [1]. The situation has not improved in the intervening years; if anything, it has grown more dire. As of early 2020, USAF senior leaders reported the shortfall had increased to **2,100** pilots [2]. This research seeks to mitigate this shortfall by reducing pilot candidate attrition during training. The goal is to determine what, if any, factors make a pilot candidate more likely to successfully complete their training, and ultimately to use this knowledge to influence future pilot selection processes.

The genesis of the current pilot shortfall can, in part, be traced back to the sequestration-driven federal budgets of 2013–2015. Unpredictable funding levels prohibited implementation of a forward-looking personnel policy and led to the limited contemporary population of junior pilots. The USAF depends on **younger** pilots to replace senior pilots. This allows senior pilots to serve in **administrative** staff positions wherein they gain headquarters (i.e., corporate-level) experience and are generally provided a reprieve from frequent deployments. The contemporary pilot shortfall has instead forced senior pilots to remain in the cockpits, reduced the pilot presence on headquarters’ staffs, and increased fears that large numbers of senior pilots will leave the service due to the fatigue caused by their operational commitments. This has caused a **ripple effect** throughout the USAF, disrupting the operations of other career fields as they surge to fill the manning void left on headquarters’ staffs.

Correcting the pilot shortage requires a multi-faceted approach. In 2020, then United States Air Force Chief of Staff (CSAF) General David Goldfein acknowledged that there is no “silver bullet” that will solve the problem [2]. A concentrated effort on several fronts to increase recruiting, reduce training attrition, improve training timeline **efficiency**, and enhance retention are all necessary efforts to ameliorate the USAF pilot shortage. The USAF has already instigated efforts on many of these fronts. Air Combat Command is revamping fighter pilot training attempting to streamline the current 40 month pipeline [3]. The Air Force Personnel Center has offered retention bonuses to senior pilots in exchange for a multi-year service commitment [4]. The United States Air Force Academy has sent an increasing number of its graduates into the pilot training pipeline [5]. Notably, Air Education and Training Command has made a concentrated effort to improve Specialized Undergraduate Pilot Training (SUPT), the initial skills training for pilots in the USAF [6]. However, efforts to reduce training attrition without sacrificing quality standards are less well-developed. Such is the focus of this study.

Given the extensive time and monetary commitments required to train a pilot [7], a candidate failure during training represents a significant loss to the USAF and is counterproductive in the attempt to reduce the current pilot shortfall. Therefore, in this study we examine how modern **machine learning** techniques may be used to build a classifier that helps to predict candidate success in SUPT. By doing so, we present a method to reduce SUPT attrition as a component of the larger endeavor to reduce the USAF pilot shortfall.

In adopting this perspective, our research extends the application of machine learning in human resource and **education**al tasks to the military environment. In the civilian sector, machine learning has been applied to hiring practices [8], job performance prediction [9], employee retention [10], and recruitment [11]. [12,13] provide thorough literature reviews in this regard. As is the case in numerous machine learning tasks, neural networks take a prominent role in human resource applications (e.g., Refs. [14,15]. Other modern techniques such as deep learning [16] and **generative** adversarial **networks** [17] are also beginning to take hold.

Despite these advancements, machine learning for human resource management or pedagogical applications in the military is much less developed; a limited number of examples exist in these areas leveraging operations research techniques of any variety (e.g., Refs. [29–32]. The relative dearth of research is noteworthy. Although related, military personnel and training systems are significantly different from their civilian counterparts; they are insular systems wherein all training and promotion occur endogenously.

Nevertheless, the DoD is increasingly looking to artificial intelligence and machine learning to increase the efficacy and efficiency of its processes [33]. With specific regard to recruiting, practitioners have recently applied machine learning to identify promising candidates for special operations forces [34]. Our research illustrates how such an approach can be extended to USAF pilot selection, another resource and time expensive training pipeline. The methods utilized herein are not necessarily meant to supplant human expertise, but rather to supplement it. That is, the machine learning algorithms examined provide decision support to humans tasked with selecting USAF pilot candidates that have the highest probability of successfully graduating. This research also illustrates how insights from the models developed herein can be used for alternative military personnel tasks (e.g., training pipeline monitoring and human resource allocation). In so doing, our research takes initial steps towards adapting the varied insights drawn from machine learning in civilian human resource management and education to the military setting.

The remaining sections of this manuscript are structured as follows. In Section 2, we provide an overview of the USAF pilot training pipeline, the empirical basis for current application testing, and an overview of recent SUPT attrition statistics. In Section 3, we provide an empirical exploration of numerous machine learning techniques to identify which subset are most promising for the development of an effective classifier. In Section 4, we illustrate the efficacy of each technique, provide experimental results relating to hyperparameter selection, and determine the relative importance of the data features. Notably, we demonstrate counter-intuitive behavior regarding the superior performance of relatively simpler techniques over others generally considered more capable. In Section 5, we discuss the relevance of our quantitative findings to USAF senior policymakers, propose a composite pilot selection index, and enumerate potential policy recommendations. Finally, in Section 6, we provide closing remarks and directions of future inquiry.

**Luckily, the Air Force is integrating AI now.**

**Underwood 24** [Kimberly Underwood, 6-3-2024, Kimberly Underwood joined SIGNAL Magazine in August of 2017. She brings with her more than 15 years experience as a reporter, writer and analyst, mostly within the energy industry "Air Force Enables ‘Responsible’ Experimenting With Generative AI," AFCEA International, https://www.afcea.org/signal-media/defense-operations/air-force-enables-responsible-experimenting-generative-ai, DOA: 3-4-2025] shaan

U.S. airmen now can experiment with generative artificial intelligence (AI) on a larger scale, Department of the Air Force (DAF) officials announced June **10** in a statement and during a briefing with reporters at the Pentagon.

Led by the DAF Chief Information Officer (CIO), Venice Goodwine, other DAF officials and researchers from the Air Force Research Laboratory (AFRL), the Air Force is providing the so-called NIPRGPT platform “to provide Airmen, Guardians, civilian employees and contractors the ability to responsibly experiment with generative AI, with adequate safeguards in place,” the DAF announced in a statement.

The NIPRGPT platform will reside on the nonclassified Internet Protocol Router Network (NIPRNet). In addition to the NIRPNET’s protections, safeguards for the generative AI platform were also developed with the U.S. Office of Personnel Management AI guidelines in mind.

The platform will allow for the responsible use of natural language models and other generative AI tools, emphasized Lynne Graves, chief of the Artificial Intelligence Division, DAF.

The other emphasis beyond security is to allow experimentation. With the sudden rise in generative AI over the last two years, Air Force officials wanted to provide room for trial and error in a safe way, with warfighters able to play and experiment. The department can only image the scores of possible use cases that might be developed.

“I truly believe the greatest contributions that integrators can make is to create other innovators,” DAF Acting Chief Data and Artificial Intelligence Officer (CDAO), Chandra Donelson, said Monday during a briefing with reporters at the Pentagon. “And to see what the Airmen and Guardians have done here with the NIPRGPT capability is phenomenal.”

The research performed by AFRL and the DAF to develop the platform, as well as the feedback from the coming users of NIPRGPT, will help shape future DAF actions around generative AI, officials explained.

“We are not committing to any single model or technology or vendor,” Donelson stated. “It is too early in the process. However, we are leveraging this effort to inform future policy, acquisition and investment decisions.”

The officials have already conducted three-related innovation roundtables with stakeholders, and they foresee continued engagement.

“As we continue to integrate AI, we want industry, large and small businesses, and **academia** to provide us insights on model benchmarking, training, as well as future investments,” Donelson noted. “As leaders, we must be able to articulate the transformation that AI or any solutions can bring to our organization. But as technology leaders, we have a responsibility to ensure that the models are fit for the purpose. So, we aim to partner with the best minds from government, industry and academia to identify which models perform better for our specific tasks and in our domains, as well as use cases to meet the needs of tomorrow's warfighters.”

To start, the officials see the generative AI platform allowing users to query the AI tools to help complete tasks such as correspondence, background papers and coding.

To this end, the DAF will also provide training **gen**erative **AI** training. And while many warfighters can easily pick up these skills, the DAF wants to deliver intentional training that is fit for purpose and culture.

“Our recent GenAI Roundtables with industry and academia have shown us this is an actively growing field,” Goodwine, the DAF CIO, said in the statement. “And now is the time to give our Airmen and Guardians the flexibility to develop the necessary skills in parallel. There are multiple modernization efforts going on right now across the federal government and within the DAF to get tools in the hands of the workforce. This tool is another one of those efforts.”

In addition, the DAF will continue to examine appropriate generative AL solutions from industry, department officials stated. “DAF senior leaders are focused on **maximizing** competitive advantage, recognizing that Airmen and Guardians need advanced technologies at the speed of relevance.”

The genesis of NIPRGPT is from AFRL’s Dark Saber software platform developed by the lab’s Information Directorate in Rome, New York, explained AFRL’s Collen Roller.

“Dark Saber is an ecosystem of Airmen and Guardians from across the DAF that brings together innovators and developers and equips them to create next-generation software and operational capabilities deployable to the Force at a rapid pace,” the DAF stated.

"NIPRGPT is a critical bridge to ensure we get the best tools we have into our team's hands while larger commercial tools are navigating our intense security parameters and other processes,” said Alexis Bonnell, AFRL CIO. “Changing how we interact with unstructured knowledge is not instant perfection; we each must learn to use the tools, query, and get the best results. NIPRGPT will allow Airmen and Guardians to explore and build skills and familiarity as more powerful tools become available."

In February, Vice Chief of the Air Force, James Slife, spoke of the service’s great demand for artificial intelligence and data management improvements to aid its operations and future capabilities.

The allowed experimentation and the arrival of NIPRGPT is one step closer to bringing AI into operations and day-to-day tasks, officials said.

Interested parties, including civilian and uniformed Airmen and Guardians, as well as contractors who are CAC holders, can register for NIPRGPT access here: https://niprgpt.mil

**That solves.**

**1. PILOT TRAINING.**

**Pereira 24** [Flavia Camargos Pereira, 6-26-24, "How the US Air Force plans to use artificial intelligence to train pilots," No Publication, https://www.shephardmedia.com/news/training-simulation/how-the-us-air-force-plans-to-use-artificial-intelligence-to-train-pilots/, DOA: 3-4-2025] shaan

The US Air Force (USAF) plans to deepen the use of artificial intelligence (AI) to improve the training for its pilots. The service intends to deploy AI technology to provide more efficient and faster preparation, in addition to better assessing and monitoring air personnel outcomes from flying instructions.

The branch envisions that AI could provide several advantages, especially in undergraduate training, which supports the air force in selecting high-quality-rated officers.

AI will enable the USAF to better tailor the preparation of flying officers by deploying a proficiency-based model instead of a stair-step or waterfall model of training whereby the pilot must accomplish certain assignments in a row in order to graduate to the next level.

Lt. Gen. Adrian Spain, deputy chief of staff for operations for the USAF, claimed that with AI and an ecosystem that allows assessing **academics**, flying training and air personnel proficiency across each of their missions, “their progression isn’t based on which event they opted for, but how proficient they are at the tasks within those events”.

During a recent webinar conducted by the Air and Space Force Association (AFA), Spain stressed that, from an execution perspective, AI would be more value added in the flying training units “where it will have applicability in the future is in monitoring and managing training over time”.

In graduate training, for the preparation period pilots undergo before arriving in operation units, the USAF foresees the use of AI in synthetic environments to train pilots in different levels of threat awareness and reaction.

“AI can help just generate that without us having to programme every single digital entity to do something at 20 miles, 25 miles, 10 miles or [simply] turn around and go home, which takes time and is frankly inefficient,” Spain noted.

“I can really determine the proficiency of the student in a way that might allow me to move faster through a programme or, at a minimum, to tailor the programme to that particular individual’s strengths and weaknesses.”

In addition to improving the training for air personnel, the USAF has also been increasing the use of AI in other domains. In 2019, the service announced a cooperative agreement with the Massachusetts Institute of Technology (**MIT**) to jointly create an AI accelerator.

Under the initiative, the branch has conducted research to enable **rapid** prototyping, scaling and ethical application of AI algorithms and systems.

In January 2020, the AI accelerator launched 10 interdisciplinary projects. The three-year projects involved 15 research workstreams and advanced **AI research** in various areas, including weather modelling and visualisation, optimisation of training schedules, and autonomy for augmenting and amplifying human decision-making.

Another USAF line-of-action involving AI has been in advancing the use of autonomous capabilities to remotely fly its aircraft fleet. As part of the Viper Experimentation and Next-gen Operations Model – Autonomy Flying Testbed (VENOM-AFT) programme, the service plans to conduct the first flight of a pilotless F-16 Fighting Falcon in 2025.

The USAF has been also advancing with the Variable In-flight Simulation Test Aircraft (VISTA) effort. In April, Frank Kendall, secretary of the air force, flew in the front seat of a X-62A VISTA aircraft at Edwards Air Force Base in California.

Moreover, the service ordered Reliable Robotics to carry out a study to evaluate the integration of the company’s aircraft-agnostic autonomous flight system into large multi-engine aircraft such as the KC-135 Stratotanker.

Early this month, as part of the service’s modernisation efforts, the branch also established a new initiative to deepen the use of generative AI (**GenAI**).

Named NIPRGPT, the project intends to accelerate initiatives to enable guardians, air personnel, civilian employees and contractors to access GenAI technology while maintaining adequate safeguards. An AI chatbot has been designed to allow users to have human-like conversations to complete various tasks such as correspondence, background papers and code.

NIPRGPT will work as an experimental bridge to leverage GenAI on the Non-classified Internet Protocol Router Network while the branch continues to explore maturing industry solutions.

**2. OFFICER TRAINING---reduced senior deployments and alleviated workloads enable on the ground support.**

**Biery 22** [Colin Biery, 2-11-2022, Capt. Colin Biery is a U.S. Air Force civil engineer officer who has provided support to operations both home-station and deployed, as well as trained officers and enlisted airmen. He recently completed a tour overseeing all mission support for a remote Space Force location. "The Weak Link in the Air Force Is Me," War on the Rocks, https://warontherocks.com/2022/02/the-weak-link-in-the-air-force-is-me/, DOA: 3-3-2025] shaan

An organization under strain will fail at its weakest link. As the U.S. Air Force faces possible wars with China and Russia, I have a bad feeling that I know where its weakest link is. If the Air Force loses its next battle, campaign, or war, it will not lose it in the air, despite some inevitable casualties, delays, and degradation. If the Air Force is truly defeated, it will be defeated on the ground. It will be defeated because the service’s combat support elements won’t be able to provide the logistics, protection, and infrastructure required while under attack. My uneasy feeling is that the Air Force’s weakest link is the tactical level leadership of its combat support units, their company-grade officers — officers like me.

At this point, the threats posed by the anti-access/area denial, cyber, and electronic warfare capabilities of America’s rivals have been discussed in great depth. For the first time in a long time, the Air Force is facing the possibility of adversaries that can hit back. The roles that potential enemies seek to target and disrupt are largely those filled by Air Force combat support. Flowing forces into theater, establishing infrastructure and networks, then sustaining and protecting it all, is my job. However, for reasons of experience, **training**, and culture, I am not ready to accomplish that job during the kind of conflict that the Air Force may very soon face. As a service, the Air Force tends to assume that its support squadrons will always be there with what it needs. It is time to take a hard look at that assumption.

Combat Support’s Competing Tasks

The opening phase of a war with China or Russia would be chaotic and generally miserable. Preparing for anything else is setting the conditions for failure, but that is what the Air Force has unintentionally done for many of its junior officers. To understand how this has happened, and what might be done to fix it, it’s first necessary to understand the competing tasks that an Air Force combat support squadron must balance.

Combat support in the Air Force is best thought of as the middle piece that connects the pointy end of the spear with the rest of the defense establishment, almost always through some form of airbase. Logistics readiness, airfield operations, security forces, civil engineering, force support, contracting, finance, maintenance and the remaining pieces of communications, constitute the Air Force’s combat support element.

A base-level combat support squadron has three main tasks. The first is preparing and presenting forces for scheduled rotational deployment. For a combat support squadron, this mainly consists of the administrative work of deployment folders, medical readiness, and commonly required computer-based training. Specialized, combat-type training (with some exceptions) is conducted just-in-time, as specified by location reporting instructions. As combat missions have ended, this training is less often required as deployment becomes more like home-station.

The second task of an Air Force combat support squadron is the day-to-day activity **required** for a military service to function, and just exist, between deployments. The maintenance of vehicles and infrastructure, law enforcement, acquisition, supply, contract oversight, housing and feeding, and everything else that goes into sustaining a large group of people, and their equipment, is a never-ending job. The task is even more consuming for mission-support groups who provide services for civilian employees, dependents, and retirees as well. The major difference between operational and support elements of the Air Force are the installation requirements. An operational squadron generally trains as a unit, deploys as a unit, and returns as a unit. A support squadron splits its forces, deploying some and retaining some in order to cover its home-station responsibilities. When a deployment rotation returns, they return to those home-station responsibilities, not preparation for future deployment. This is also the big difference in how the Air Force does combat support versus the other services, who normally separate their installation and combat support functions.

The third task that a combat support squadron must balance has gained importance as the Defense Department focuses more on great powers. Even five years ago (outside of Pacific Air Forces) training for a high-intensity conflict was a quick check-the-box exercise, if it happened at all. Now, squadrons are trying to develop airmen to fight a future great-power war. This may seem interchangeable with presenting forces for rotational deployments. However, the differences between a scheduled deployment to an aligned Persian Gulf state and a scrambling deployment into a contested environment in the Western Pacific or Eastern Europe mean that preparing for the first doesn’t cover the second. The ability to survive and operate a base under attack requires a skillset that needs to be intentionally built. Add in chemical, biological, and nuclear threats and cyber disruption, and you have a **significant** training requirement.

The possibility of high-intensity conflict has also driven the Air Force to develop new concepts to operate when contested throughout a theater. Agile combat employment, agile combat support, distributed operations, and multi-capable airmen all aim to make the flying service more flexible and resilient. All center on using smaller, distributed teams to quickly establish bases that present too many targets for an enemy to effectively suppress. All require combat support that can work independently and flexibly across large distances. The junior officers responsible for that support will have to make decisions, solve problems, and balance risks while under attack. However, the training and experience of officers like myself, and the culture we come up in, isn’t preparing us to meet that challenge. The Department of Defense talks about deployment into a future theater as a movement to contact. Unless the Air Force’s combat support communities make conscious decisions to change, failure when making that movement is a real possibility.

Efficiency Over Experience

A combination of limited budgets and the need to fund modernization has obliged the Air Force to find efficiencies in providing installation support. In practice this has meant centralization and “data driven,” decision-making. These changes may have increased efficiency, but it has been at the expense of **learning** experience for combat support company-grade officers, who have increasingly become providers of data and certifiers of compliance for decision-makers who are often not even at the same base. Lieutenants spend their time building slide decks and inputting numbers into web-based tools, rather than learning and practicing leadership. Captains wrestle with using the correct process and documentation to get base priorities taken care of, rather than working toward a solution with their teams. The contracting-out of base functions, such as information technology and utilities, has added to the problem by making junior officers monitors of someone else, instead of being responsible for executing programs themselves. Compounding everything is the natural increase of micromanagement as the Air Force returns to a peacetime footing. Even decisions that can be made at base level often turn into a morass of meetings and consensus-building. Until recently, deployment offered a more varied experience, but the move towards enduring bases in the Middle East has extended home-station bureaucracy to those locations as well. The result is that combat support company-grade officers build expertise in navigating the Air Force’s bureaucracy at the expense of other skills. It is unrealistic to expect an officer who has been tied to Microsoft Outlook his or her whole career to suddenly conduct their mission without reliable communications. Even more unrealistic is expecting a junior officer who has only ever built slide decks for decision-makers to start thinking on their feet and making quick, independent decisions under pressure.

A seemingly apparent solution to the experience problem is rolling back the burden of centralization and data-gathering, but the fully legitimate need for efficiency and auditability makes this approach unlikely and probably unworkable. The actual solution is more local. Base-level combat support squadrons should make conscious choices to maximize the time of their company-grade officers away from their computers. The goal for these officers should be working short timeline tasks that allow for actual decision-making, and then dealing with the consequences of those decisions. Programming five-year infrastructure plans, overseeing installation service contracts, and managing the civilian personnel system are all essential activities, but are poor preparation for providing agile combat support under fire. Company-grade officers, especially new lieutenants, need to be put in positions where they work directly with the enlisted force and practice their leadership skills. Although it may mean that their names aren’t attached to the high-visibility initiatives that make great performance report bullets, young officers need to be in charge where the authorities are right, and the consequences of failure are low enough, that they can actually be in charge. Last, but not least, leadership throughout the command should resist **micromanaging**, even if it means some clean-up later on.

More relevant experience is the right place to start, but the skillset for a high-intensity peer conflict is different than for home-station operations or ongoing deployments. Just like aircrew need flight hours to build and maintain proficiency with their aircraft, combat support officers need training hours to build and maintain wartime skills. Developing multi-capable airmen increases the training required by adding skills beyond their functional area for personnel to learn. In theory, training time was to be freed up by reduced rotational deployments to the Middle East and Africa. However, those reductions have been uneven and often reversed. This leaves combat support squadrons in a position where training for both their officers and their enlisted forces has to come out of time normally spent providing installation support and services. That training time is only one day per month and one exercise per year for many squadrons, and often less for individual members. While it can’t be proven short of fighting in an actual war, that time investment likely isn’t sufficient. There is also a less obvious, but equally impactful, problem. Useful training requires extensive time and effort from more **senior** company-grade officers and non-commissioned officers to plan, teach, and track it. The ongoing demands of deployments and installation support make it a struggle for squadrons to build effective training programs, because the **personnel** qualified to run them are overwhelmingly focused on other tasks.

**Training is a subset of education.**

**Brody 19** [Maureen Brody, 7-15-2019, Maureen Brody is a Curriculum and Instructional Design specialist with a background in document production, technical writing and editing, and project management. "What Is The Difference Between Training And Education?," Becht, https://becht.com/becht-blog/entry/what-is-the-difference-between-training-and-education/, DOA: 3-2-2025] shaan

Training refers to the acquisition of specific and applied knowledge and skills. Training can occur in a variety of settings, including within a **classroom**, but frequently training takes place “on the job” or “in the field.” The purpose of training is to improve performance and productivity among employees, typically with a focus on one set of skills. Training usually occurs after employment has already been secured, and is usually mandated, provided by, and funded by one’s employer. Although some training courses can last for multiple weeks, training courses are usually of a much shorter duration than educational courses due to the fact that training encompasses more specific and focused topics.

To put it simply, training is a much more specialized form of **education**. It can fall under the umbrella of education as both training and education focus on the acquisition of knowledge, but training is much more task-oriented, and skills based.

So, you may be wondering, why is continued training necessary within the workforce? Can’t employees be trained once, educated once on a particular topic, and then perform effectively?

**Air superiority prevents extinction.**

**Birkey ’24** [Douglas; June 13; Executive Director for the Mitchell Institute for Aerospace Power Studies, Master’s in International Relations from Georgetown University; Air and Space Forces, “Past is Prologue: Learn from History and Invest in Combat Airpower,” https://www.airandspaceforces.com/opinion-past-is-prologue-invest-in-combat-airpower/]

As world leaders gathered at Normandy last week to mark the 80th anniversary of the D-Day invasion, it is important to recall that America was not ready for that war. It took two and a half years to generate the combat power necessary to invade Europe, plus another year to finally defeat Nazi Germany. Victory was far from certain during key phases of the conflict.

Today, America is once again inadequately postured to confront burgeoning national security challenges. China is building up forces aggressively in the Pacific; Russia is making gains in its war on Ukraine; Iran is pursuing nuclear ambitions and proxy wars; North Korea is threatening nuclear war; and non-state actors continue to destabilize key regions. However, post-Cold War budget cuts, two decades of strategic distraction in Afghanistan and Iraq, and a succession of aggressive budget cuts have yielded a set of U.S. military capabilities and capacity that fall short of what the threat environment demands. This is especially true for Air Force fighters and bombers—two foundational elements of U.S. national security.

The ability to achieve air superiority when and where it is needed is an essential condition for any successful military operation, regardless of domain. That is why Air Force fighters are so important.

Likewise, a commander’s ability to take the fight to the enemy depends on America’s long-range attack capability—which is predominantly an Air Force bomber mission. They strike targets deep behind enemy lines, disable command-and-control networks, eliminate production centers, and damage materiel, logistics, and enemy combat forces. Bombers, in addition to submarines and land-based ICBMs, also comprise one leg of America’s nuclear triad. Combined, air superiority and long-range attack **deter** adversaries in times of peace and yield war-winning effects during conflict.

Both air superiority and long-range attack missions are established military imperatives. In World War II, allied forces would not have made it past the landing beaches had they been under attack from the sky. Long-range strikes played a crucial role throughout the war, degrading the German war machine with debilitating attacks against petroleum refineries, production facilities, rail lines, and more. The reason the war in Europe ended just eleven months after D-Day was that air power had already inflicted so much damage over the years, that ground forces were fighting an already degraded opponent.

The same was true in Operation Desert Storm in 1991. A monthlong air campaign set conditions such that ground forces needed just 96 hours to bring Saddam Hussein to his knees.

Today, in Ukraine, neither side controls the sky, and neither can mount a strategic air attack campaign. As a result, fighting is bogged down in modern-day World War I-style trench warfare. This is the price nations pay if they cannot control the sky and use that dominance to project decisive strikes. Surface forces slaughter each other for incremental daily gains measured in meters.

Following such a course is a recipe for disaster. Yet given the precarious state of U.S. airpower today, it could be what is in store if the U.S. faces a major power, especially China, in combat in the future. Lacking major investment today, commanders will lack the capacity and capability they will need to fight a peer foe.

The decay began after the fall of the Soviet Union in 1991, when the Pentagon cut Air Force combat capacity by half. In continued over the decades that followed, as fighter and bomber inventories shrank and nonstop operational demand in the Middle East, the Balkans, and elsewhere burned out remaining aircraft. At the same time, key fighter and bomber modernization programs were cut short. America built less than half the F-22s required, halted B-2 bomber production at 21, slowed F-35 production, and flew aircraft into their sixth decade and beyond. Fiscal caps imposed by the 2011 Budget Control Act strained Air Force fighters and bombers to the core.

Air Force leaders sounded the alarm six years ago, declaring that “The Air Force is too small for what the nation is asking us to do.” Yet still the cuts continued.

Now, with threats on the rise around the globe, the nation faces a choice: modernize or risk the nation’s future security. Said more bluntly, America may lose its next major war it fights for want of capable, properly sized combat airpower.

To avert this outcome, modernization is essential. This includes:

Buying more F-35 and B-21 aircraft as rapidly as possible

Developing and fielding autonomous, uncrewed Collaborative Combat Aircraft (CCA)

Building the Next Generation Air Dominance (NGAD) family of systems

Investing in modern munitions in volume

Fixing the chronic pilot shortfall

Stop shortchanging operations accounts so that personnel are adequately trained, and mission equipment is sustained at a high level of readiness.

A credible force can deter war, but a hollow force—one that lacks the capacity to fight a peer adversary—invites risk. Adversaries **know** when America is weak and will opportunistically push against our interests.

However, modernization requires resources, and that funding is in short supply given new budget caps, continued high inflation, and the sheer scale of modernization necessary to reset decades of neglect. The factors risk seeing an already a fragile set of Air Force combat airpower capabilities grow more precarious. The Air Force reduced its fiscal 2025 procurement budget request by $1.6 billion versus fiscal 2024, because the resources simply were not available in the topline dictated by the Pentagon. According to experts, the defense budget caps amount to a $47 billion cut to the Department of Defense in fiscal 2025 versus previously planned toplines.

Nor are things set to improve any time soon. Secretary of the Air Force Frank Kendall explained: “You’re going to see our five-year plan … and what you’re going to see is that life gets a lot harder as we get past ’25.”

Given what is at stake, Congress must repeal the budget caps and prioritize Air Force modernization. The joint force simply is not viable without what Air Force fighters and bombers bring to the fight. Nor can these deferred bills be ignored forever. As Senate defense appropriations subcommittee Chairman Sen. Jon Tester (D-Mont.) knows well, the cost of postponing necessary investments is always higher: “Either pay me now or pay me later,” he has said. “It’s going to cost a hell of a lot more later.”

Ranking member of the Senate Armed Services Committee Sen. Roger Wicker (R-Miss.) is calling for higher defense spending. “Our current defense investment does not meet the moment,” he said, releasing a plan that deserves serious bipartisan attention. “The emerging Axis of Aggressors is undermining U.S. interests across the globe.”

On top of more funding, the Department of Defense also needs to embrace cost per effect analysis to ensure money received is directed towards achieving best value. It comes down to investing in systems that deliver the greatest effect at the lowest cost, thus buying more defense capability and capacity for each dollar invested.

There is significant room for improvement in this regard. Consider the long-range strike mission. While deep attack is officially and traditionally an Air Force mission achieved with bomber and fighter aircraft, the Pentagon has funded the Army and Navy to develop long-range missiles that will cost $50 million per shot—an unsustainable figure given that aim points in a major theater war will likely exceed six figures. Stealthy penetrating fighters and bombers can achieve greater effects at a fraction of that cost, return to base, and do it again the next day.

Nor is this the only example. Consider the inefficiency of the Army trying to develop its own organic intelligence, surveillance, and reconnaissance capability, comprising both aircraft and satellites, to guide those high-priced long-range missiles. The Space Force, meanwhile, is developing that same capability for the entire joint force.

In his remarks commemorating the D-Day anniversary, President Biden noted that “There are things that are worth fighting and dying for: Freedom is worth it; democracy is worth it; America is worth it; the world is worth it—then, now, and always.”

While some might call that sentimental hyperbole, the lessons of the past tell us otherwise. World War II put existential realities on the line. China, Russia, and the rest of the threats we face pose severe risks today.

As we once again face these challenges, some of them truly existential, let us resolve to rise to the occasion as did our nation nearly a century ago. We must invest now to ensure American air superiority and long-range strike capability are there when we need them.

**Extinction**

**Clare 23** [Stephen Clare; Effective Altruism Writer; June 2023; "Great power war"; 80000 Hours; https://80000hours.org/problem-profiles/great-power-conflict/; accessed 12-05-2024]

A modern **g**reat **p**ower **w**ar could see **nuclear weapons**, **bioweapons**, **autonomous weapons**, and other **destructive** new **technologies** deployed on an **unprecedented scale**.

It would **probably** be the **most destructive** event in **history**, **shattering** our **world**. It could **even threaten** us with **extinction**.

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We’ve come perilously close to just this kind of catastrophe before. On October 27, 1962 — near the peak of the Cuban Missile Crisis — an American U-2 reconnaissance plane set out on a routine mission to the Arctic to collect data on Soviet nuclear tests. But, while flying near the North Pole, with the stars obscured by the northern lights, the pilot made a navigation error and strayed into Soviet airspace.1 Soviet commanders sent fighter jets to intercept the American plane. The jets were picked up by American radar operators and nuclear-armed F-102 fighters took off to protect the U-2. Fortunately, the reconnaissance pilot realised his error with enough time to correct course before the Soviet and American fighters met. But the intrusion enraged Soviet Premier Nikita Khrushchev, who was already on high alert amidst the crisis in Cuba. “What is this, a provocation?” Khrushchev wrote to US President John F. Kennedy. “One of your planes violates our frontier during this anxious time when everything has been put into combat readiness.” If the U-2’s path had strayed further west, or the Soviet fighters had been fast enough to intercept it, this incident could have played out quite differently. Both the United States and the USSR had thousands of nuclear missiles ready to fire. Instead of a nearly-forgotten anecdote, the U-2 incident could have been a trigger for war, like the assassination of Franz Ferdinand.

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**Competition** among the world’s **most powerful** countries **shapes** our **world** today. And whether it’s through future incidents like the lost U-2, or something else entirely, it’s plausible that it could escalate and lead to a major, devastating war.

Is there anything you can do to help avoid such a terrible outcome? It is, of course, difficult to imagine how any one individual can hope to influence such world-historical events. Even the **most powerful** world **leaders** often **fail** to predict the **global consequences** of **their decisions**.

But I think the **likelihood** and **severity** of **g**reat **p**ower **w**ar makes this **among** the **most pressing** problems of **our time** — and that **some solutions** could be **impactful** enough that **working** on them may be one of the **highest-impact** things to do with **your career**.

By taking action, I think we **can create** a **future** where the **threat** of **g**reat **po**wer **w**ar is a **distant memory** rather than an **ever-present** danger.

Summary

**Economic growth** and **technological progress** have **bolstered** the **arsenals** of the world’s **most powerful** countries. That means the **next war** between **them** could be **far worse** than **W**orld **W**ar **II**, the **deadliest conflict** humanity has **yet experienced**.

Could **such** a war **actually occur**? We can’t rule out the possibility. **Technical accidents** or **diplomatic misunderstandings** could **spark** a **conflict** that **quickly escalates**. Or **international tension** could **cause leaders** to decide they’re **better off** fighting than **negotiating**.

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It seems hard to make progress on this problem. It’s also less neglected than some of the problems that we think are most pressing. There are certain issues, like making nuclear weapons or military artificial intelligence systems safer, which seem promising — although it may be more impactful to work on reducing risks from AI, bioweapons or nuclear weapons directly. You might also be able to reduce the chances of misunderstandings and miscalculations by developing expertise in one of the most important bilateral relationships (such as that between the United States and China). Finally, by making conflict less likely, reducing competitive pressures on the development of dangerous technology, and improving international cooperation, you might be helping to reduce other risks, like the chance of future pandemics. Our overall view Recommended Working on this issue seems to be among the best ways of improving the long-term future we know of, but all else equal, we think it’s less pressing than our highest priority areas (primarily because it seems less neglected and harder to solve). Scale There’s a significant chance that a new great power war occurs this century. Although the world’s most powerful countries haven’t fought directly since World War II, war has been a constant throughout human history. There have been numerous close calls, and several issues could cause diplomatic disputes in the years to come. These considerations, along with forecasts and statistical models, lead me to think there’s about a one-in-three chance that a new great power war breaks out in roughly the next 30 years. Few wars cause more than a million casualties and the next great power war would probably be smaller than that. However, there’s some chance it could escalate massively. Today the great powers have much larger economies, more powerful weapons, and bigger military budgets than they did in the past. An all-out war could kill far more people than even World War II, the worst war we’ve yet experienced. Could it become an existentially threatening war — one that could cause human extinction or significantly damage the prospects of the long-term future? It’s very difficult to say. But my best current guess is that the chance of an existential catastrophe due to war in the next century is somewhere between 0.05% and 2%. Neglectedness War is a lot less neglected than some of our other top problems. There are thousands of people in governments, think tanks, and universities already working on this problem. But some solutions or approaches remain neglected. One particularly promising approach is to develop expertise at the intersection of international conflict and another of our top problems. Experts who understand both geopolitical dynamics and risks from advanced artificial intelligence, for example, are sorely needed. Solvability Reducing the risk of great power war seems very difficult. But there are specific technical problems that can be solved to make weapons systems safer or less likely to trigger catastrophic outcomes. And in the best case, working on this problem can have a leverage effect, making the development of several dangerous technologies safer by improving international cooperation and making them less likely to be deployed in war. At the end of this profile, I suggest five issues which I’d be particularly excited to see people work on. These are: Developing expertise in the riskiest bilateral relationships Learning how to manage international crises quickly and effectively and ensuring the systems to do so are properly maintained Doing research to improve particularly important foreign policies, like strategies for sanctions and deterrence Improving how nuclear weapons and other weapons of mass destruction are governed at the international level Improving how such weapons are controlled at the national level Profile depth In-depth This is one of many profiles we've written to help people find the most pressing problems they can solve with their careers. Learn more about how we compare different problems, see how we try to score them numerically, and see how this problem compares to the others we've considered so far. Why might preventing great power war be an especially pressing problem? A modern great power war — an all-out conflict between the world’s most powerful countries — could be the worst thing to ever happen to humanity. Historically, such wars have been exceptionally destructive. Sixty-six million people died in World War II, likely the deadliest catastrophe humanity has experienced so far. Since World War II, the global population and world economy have continued to grow, nuclear weapons have proliferated, and military technology has continued to advance. This means the next world war could be even worse, just as World War II was much deadlier than World War I. It’s not guaranteed that such a war will break out. And if it does, it may not escalate to such a terrible extent. But the chance can’t be ignored. In fact, there are reasons to think that the odds of World War III breaking out this century are worryingly high. A modern great power war would be devastating for people alive today. But its effects could also persist long into the future. That’s because there is a substantial chance that this century proves to be particularly important. Technologies with the potential to cause a global catastrophe or radically reshape society are likely to be invented. How we choose to develop and deploy them could impact huge numbers of our descendants. And these choices would be affected by the outcomes of a major war. To be more specific, there are three main ways great power conflict could affect the long-term future: High international tension could increase other risks. Great power tensions could make the world more dangerous even if they don’t lead to war. During the Cold War, for example, the United States and the USSR never came into direct conflict but invested in bioweapons research and built up nuclear arsenals. This dynamic could return, with tension between great powers fueling races to develop and build new weapons, raising the risk of a disaster even before shots are fired. War could cause an existential catastrophe. If war does break out, it could escalate dramatically, with modern weapons (nuclear weapons, bioweapons, autonomous weapons, or other future technologies) deployed at unprecedented scale. The resulting destruction could irreparably damage humanity’s prospects. War could reshape international institutions and power balances. While such a catastrophic war is possible, it seems extremely unlikely. But even a less deadly war, such as another conflict on the scale of World War II, could have very long-lasting effects. For example, it could reshape international institutions and the global balance of power. In a pivotal century, different institutional arrangements and geopolitical balances could cause humanity to follow different long-term trajectories. The rest of this profile explores exactly how pressing a problem great power conflict is. In summary: Great power relations have become more tense. (More.) Partly as a result, a war is more likely than you might think. It’s reasonable to put the probability of such a conflict in the coming decades somewhere between 10% and 50%. (More.) If war breaks out, it would probably be hard to control escalation. The chance that it would become large enough to be an existential risk cannot be dismissed. (More.) This makes great power war one of the biggest threats our species currently faces. (More.) It seems hard to make progress on solving such a difficult problem (more) — but there are many things you can try if you want to help (more). International tension has risen and makes other problems worse Imagine we had a thermometer-like device which, instead of measuring temperature, measured the level of international tension.2 This ‘tension metre’ would max out during periods of all-out global war, like World War II. And it would be relatively low when the great powers3 were peaceful and cooperative. For much of the post-Napoleonic 1800s, for example, the powerful European nations instituted the Concert of Europe and mostly upheld a continental peace. The years following the fall of the USSR also seem like a time of relative calm, when the tension metre would have been quite low.4 How much more worried would you be about the coming decades if you knew the tension metre would be very high than if you knew it would be low? Probably quite a lot. In the worst case, of course, the great powers could come into direct conflict. But even if it doesn’t lead to war, a high level of tension between great powers could accelerate the development of new strategic technologies, make it harder to solve global problems like climate change, and undermine international institutions. During the Cold War, for instance, the United States and USSR avoided coming into direct conflict. But the tension metre would still have been pretty high. This led to some dangerous events: A nuclear arms race. The number of nuclear warheads in the world grew from just 300 in 1950 to over 64,000 in 1986. The development of new bioweapons. Despite signing the Biological Weapons Convention in 1972, the search for military advantages motivated Soviet decision makers to continue investing in bioweapon development for decades. Although never used in combat, biological agents were accidentally released from research facilities, resulting in dozens of deaths and threatening to cause a pandemic.5 Nuclear close calls. Military accidents and false alarms happened regularly, and top decision makers were more likely to interpret these events hostilely when tensions were high. On several occasions it seems the decision about whether or not to start a nuclear war came down to individuals acting under stress and with limited time. This makes international tension an existential risk factor. It’s connected to a number of other problems, which means reducing the level of international tension would lower the total amount of existential risk we face. The level of tension today Recently, international tension seems to have once again been rising. To highlight some of the most salient examples: China-United States relations have deteriorated, leading to harsh diplomatic rhetoric and protectionist trade policies that aim to reduce the countries’ economic interdependence. Russia’s invasion of Ukraine has killed about a hundred thousand people so far, raised the risk of nuclear war, and sent United States-Russia relations to their lowest point since the Cold War. Chinese and Indian soldiers fought deadly skirmishes along their countries’ disputed border in 2020–21. These dynamics raise an important question: how much more dangerous is the world given this higher tension than it would be in a world of low tension? I think the answer is quite a bit more dangerous — for several reasons. First, international tension seems likely to make technological progress more dangerous. There’s a good chance that, in the coming decades, humanity will make some major technological breakthroughs. We’ve discussed, for example, why one might worry about the effects of advanced artificial intelligence systems or biotechnology. The level of tension could strongly affect how these technologies are developed and governed. Tense relations could, for example, cause countries to neglect safety concerns in order to develop technology faster.6 Second, great power relations will strongly influence how nations do, or do not, cooperate to solve other global collective action problems. For example, in 2022, China withdrew from bilateral negotiations with the United States over climate action in protest of what it perceived as American diplomatic aggression in Taiwan. That same year, efforts to strengthen the Biological Weapons Convention were reportedly hampered by the Russian delegation after their country’s invasion of Ukraine raised tensions with the United States and other western countries. And third, if relations deteriorate severely, the great powers could fight a war. How likely is a war? Wars are destructive and risky for all countries involved. Modern weapons, especially nuclear warheads, make starting a great power war today seem like a suicidal undertaking. But factors like the prevalence of war throughout history, the chance that leaders make mistakes, conflicting ideologies, and commitment problems, make me think that conflict could break out anyway. On balance, I think such an event is somewhat unlikely but hardly unthinkable. To quantify this: I put the chance we experience some kind of war between great powers before 2050 at about one-in-three.7 War has occurred regularly in the past One reason to think a war is quite likely is that such conflicts have been so common in the past. Over the past 500 years, about two great power wars have occurred per century.8 Naively, this would mean that every year there’s a 2% chance such a war occurs, implying the chance of experiencing at least one great power war over the next 80 years — roughly until the end of the century — is about 80%.9 This is a very simple model. In reality, the risk is not constant over time and independent across years. But it shows that if past trends simply continue, the outcome is likely to be very bad. Has great power war become less likely? One of the most important criticisms of this model is that it assumes the risk is constant over time. Some researchers have argued instead that, especially since the end of World War II, major conflicts have become much less likely due to: Nuclear deterrence: Nuclear weapons are so powerful and destructive that it’s just too costly for nuclear-armed countries to start wars against each other.10 Democratisation: Democracies have almost never gone to war against each other, perhaps because democracies are more interconnected and their leaders are under more public pressure to peacefully resolve disputes with each other.11 The proportion of countries that are democratic has increased from under 10% in 1945 to about 50% today. Strong economic growth and global trade: Global economic growth accelerated following World War II and the value of global exports grew by a factor of almost 30 between 1950 and 2014. Since war disrupts economies and international trade, strong growth raises the costs of fighting.12 The spread of international institutions: Multilateral bodies like the United Nations General Assembly and Security Council promote diplomatic dialogue and facilitate coordination to punish transgressors.13 It is true that we are living through an unusually long period of great power peace. It’s been about 80 years since World War II. We just saw that a simple model using the historical frequency of great power wars suggests there was only a 20% chance of going that long without at least one more war breaking out. This is some evidence in favour of the idea that wars have become significantly less common. At the same time, we shouldn’t feel too optimistic. The numerous close calls during the Cold War suggest we were somewhat lucky to avoid a major war in that time. And a 20% chance of observing 80 years of peace is not that low.14 Structural changes might have dramatically reduced the likelihood of war. Or perhaps we’ve just been lucky. It could even be that technological advances have made war less likely to break out, but more deadly when it occurs, leaving the overall effect on the level of risk ambiguous. It just hasn’t been long enough to support a decisive view.15 So while the recent historical trend is somewhat encouraging, we don’t have nearly enough data to be confident that great power war is a thing of the past. To better predict the likelihood of future conflict, we should also consider distinctive features of our modern world.16 One might think that a modern great power war would simply be so destructive that no state leader would ever choose to start one. And some researchers do think that the destruction such a war would wreak globally makes it less likely to occur. But it would be hard to find anyone who claims this dynamic has driven the risk to zero. First, a war could be started by accident. Second, sometimes even prudent leaders may struggle to avoid a slide towards war. We could blunder into war An accidental war can occur if one side mistakes some event as an aggressive action by an adversary. This happened several times during the Cold War. The earlier example of the wayward American reconnaissance plane shows how routine military exercises carry some escalation risk. Similarly, throughout history, nervous pilots and captains have caused serious incidents by attacking civilian planes and ships.17 Nuclear weapons allow for massive retaliatory strikes to be launched quickly — potentially too quickly to allow for such situations to be explained and de-escalated. It is perhaps more likely, though, that an accidental war could be triggered by a technological malfunction. Faulty computers and satellites have previously triggered nuclear close calls. As monitoring systems have become more reliable, the rate at which such accidents have occurred has been going down. But it would be overconfident to think that technological malfunctions have become impossible. Future technological changes will likely raise new challenges for nuclear weapon control. There may be pressure to integrate artificial intelligence systems into nuclear command and control to allow for faster data processing and decision making. And AI systems are known to behave unexpectedly when deployed in new environments.18 New technologies will also create new accident risks of their own, even if they’re not connected to nuclear weapon systems. Although these risks are hard to predict, they seem significant. I’ll say more about how such technologies — including AI, nuclear, biological, and autonomous weapons — are likely to increase war risks later. Leaders could choose war All that said, most wars have not started by accident. If another great power war does break out in the coming decades, it is more likely to be an intentional decision made by a national leader. Explaining why someone might make such a costly, destructive, unpredictable, and risky decision has been called “the central puzzle about war.” It has motivated researchers to search for “rationalist” explanations for war. In his 2022 book Why We Fight, for example, economist Chris Blattman proposes five basic explanations: unchecked interests, intangible incentives, uncertainty, commitment problems, and misperceptions.19 Blattman's Five (Rationalist) Explanations for War This section discusses how great power tensions may escalate to war in the next few decades. It focuses on three potential conflicts in particular: war between the US and China, between the US and Russia, and between China and India. These are discussed because each of these countries are among the world’s largest economies and military spenders, and seem particularly likely to fight. At the end, I briefly touch on other potential large conflicts. Projected real GDP of the US, China, India and Russia according to a 2022 Goldman Sachs analysis Source: Author’s figure using data from: Kevin Daly and Tadas Gedminas, “Global Economics Paper The Path to 2075 — Slower Global Growth, But Convergence Remains Intact,” Global Economics Paper (Goldman Sachs, December 6, 2022), https://www.goldmansachs.com/intelligence/pages/gs-research/the-path-to-2075-slower-global-growth-but-convergence-remains-intact/report.pdf. United States-China The most worrying possibility is war between the United States and China. They are easily the world’s largest economies. They spend by far the most on their militaries. Their diplomatic relations are tense and have recently worsened. And their relationship has several of the characteristics that Blattman identifies as causes of war. At the core of the United States-China relationship is a commitment problem. China’s economy is growing faster than the United States’. By some metrics, it is already larger.20 If its differential growth continues, the gap will continue to widen between it and the United States. While economic power is not the sole determinant of military power, it is a key factor.21 The United States and China may be able to strike a fair deal today. But as China continues to grow faster, that deal may come to seem unbalanced. Historically, such commitment problems seem to have made these kinds of transition periods particularly dangerous.22 In practice, the United States and China may find it hard to agree on rules to guide their interactions, such as how to run international institutions or govern areas of the world where their interests overlap. The most obvious issue which could tip the United States-China relationship from tension into war is a conflict over Taiwan. Taiwan’s location and technology industries are valuable for both great powers. This issue is further complicated by intangible incentives. For the United States, it is also a conflict over democratic ideals and the United States’ reputation for defending its allies. For China, it is also a conflict about territorial integrity and addressing what are seen as past injustices. Still, forecasts suggest that while a conflict is certainly possible, it is far from inevitable. As of 8 June 2023, one aggregated forecast23 gives a 17% chance of a United States-China war breaking out before 2035.24 A related aggregated forecast of the chance that at least 100 deaths occur in conflict between China and Taiwan by 2050 gives it, as of 8 June 2023, a much higher 68% chance of occurring.25 United States-Russia Russia is the United States’ other major geopolitical rival. Unlike China, Russia is not a rival in economic terms: even after adjusting for purchasing power, its economy is only about one-fifth the size of the United States’. However, Russia devotes a substantial fraction of its economy to its military. Crucially, it has the world’s largest nuclear arsenal. And Russian leadership has shown a willingness to project power beyond their country’s borders. Country Military spending in 2021 (2020 USD, PPP adjusted) United States 801 billion China 293 billion India 76.6 billion United Kingdom 68.4 billion Russia 65.9 billion Top five countries by estimated military spending, 2021. Source: SIPRI Russia’s 2022 invasion of Ukraine demonstrated the dangers of renewed rivalry between Russia and the United States-led West. The war has already been hugely destructive: the largest war in Europe since World War II, with hundreds of thousands of casualties already and no end to the conflict in sight. And it could get much worse. Most notably, Russian officials have repeatedly refused to rule out the use of nuclear weapons. Unchecked interests and intangible incentives are again at play here. Vladimir Putin leads a highly-centralised government. He has spoken about how his desire to rebuild Russia’s reputation played in his decision to invade Ukraine. Given their ideological differences and history of rivalry, it is reasonable to expect that the United States and Russia will continue to experience dangerous disagreements in the future. As of 8 June 2023, an aggregated forecast gives a 20% chance that the United States and Russia will fight a war involving at least 1,000 battle deaths before 2050. China-India India is already the world’s third-largest economy. If national growth rates remain roughly constant, the size of the Indian economy will surpass that of the United States’ sometime this century. India also has nuclear weapons and is already the world’s third-largest military spender (albeit at a much lower level than China or the United States). One reason to worry that China and India could fight a war is that they already dispute territory along their border. Countries that share a border, especially when it is disputed, are more likely to go to war than countries that do not. By one count, 88% of the wars that occurred between 1816 and 1980 began as wars between neighbours.26 In fact, China and India already fought a brief but violent border war in 1962. Deadly skirmishes have continued since, resulting in deaths as recently as 2020. Forecasters agree that a China-India conflict seems relatively (though not absolutely) likely. An aggregated forecast gives a 19% chance of war before 2035. Other dangerous conflicts These three conflicts — United States-China, United States-Russia, and China-India — are not the only possible great power wars that could occur. Other potential conflicts could also pose existential risk, either because they drive dangerous arms races or see widespread deployment of dangerous weapons. We should keep in mind India-Pakistan as a particularly likely conflict between nuclear-armed states and China-Russia as a potential, though unlikely, conflict between great powers with a disputed border and history of war. Plus, new great powers may emerge or current great powers may fade in the years to come. While I think we should prioritise the three potential conflicts I’ve highlighted above, the future is highly uncertain. We should monitor geopolitical changes and be open to changing our priorities in the future. Overall predictions Below is a table listing relevant predictions from the forecasting platform Metaculus, including the number of predictions made, as of 10 March 2023. Note the different timescales and resolution criteria for each question; they may not be intuitively comparable. Prediction Resolution criteria Number of predictions Metaculus prediction World war by 2151 Either: A war killing >0.5% of global population, involving >50% of countries totalling >50% of global population from at least 4 continents. Or: A war killing at least >1% of global population, involving >10% of countries totalling >25% of global population 561 52% World War III before 2050 Involving countries >30% of world GDP OR >50% of world population AND >10M deaths 1640 20% Global thermonuclear war by 2070 EITHER: 3 countries each detonate at least 10 nuclear warheads of at least 10 kt yield outside of their territory OR 2 countries each detonate at least 50 nuclear warheads of at least 10 kt outside of their territory 337 11% When will be the next great power war? Any two of the top 10 nations by military spending are at war “At war” definition: EITHER Formal declaration OR Territory occupied AND at least 250 casualties OR Media sources describe them as “at war” 25th percentile: 2031 Median: 2048 75th percentile: 2088 Never (not before 2200): 8% No non-test nuclear detonations before 2035 No nuclear detonation other than controlled test [Note the negation in the question. It resolves negatively if a warhead is detonated] 321 69% At least 1 nuclear detonation in war by 2050 Resolves according to credible media reports 476 31% I have previously independently estimated the likelihood of seeing a World War III-like conflict this century. My calculation first adjusts historical base rates to allow for the possibility that major wars have become somewhat less likely, and uses the adjusted base rate to calculate the probability of seeing a war between now and 2100. This method gives a 45% chance of seeing a major great power war in the next 77 years. If the probability is constant over time then the cumulative probability between now and 2050 would be 22%. This is aligned with the Metaculus predictions above. We can also ask experts what they think. Unfortunately, there are surprisingly few expert predictions about the likelihood of major conflict. One survey was conducted by the Project for the Study of the 21st Century. The numbers were relatively aligned with the Metaculus forecasts, though slightly more pessimistic. However, it seems a mistake to put too much stock in this survey (see footnote).27 We now have at least a rough sense of a great power war’s probability. But how bad could it get if it occurred? A new great power war could be devastating At the time, the mechanised slaughter of World War I was a shocking step-change in the potential severity of warfare. But its severity was surpassed just 20 years later by the outbreak of World War II, which killed more than twice as many people. A modern great power war could be even worse. How bad have wars been in the past? The graph below shows how common wars of various sizes are, according to the Correlates of War’s Interstate War dataset.28 The x-axis here represents war size in terms of the logarithm of the number of battle deaths. The y-axis represents the logarithm of the proportion of wars in the dataset that are at least that large. Using logarithms means that each step to the right in the graph represents a war not one unit larger, but 10 times larger. And each step up represents a war that is not one unit more likely, but 10 times more likely. Cumulative frequency distribution of severity of interstate wars, 1816-2007 Source: Author’s figure. See the data here. Data source: Correlates of War Interwar dataset, v4.029 What the graph shows is that wars have a heavy tail. Most wars remain relatively small. But a few escalate greatly and become much worse than average. Of the 95 wars in the latest version of the database, the median battle death count is 8,000. But the heavy tail means the average is 334,000 battle deaths. And the worst war, World War II, had almost 17 million battle deaths.30 The number of battle deaths is only one way to measure the badness of wars. We could also consider the proportion of the population of the countries involved who were killed in battle. By this measure, the worst war since 1816 was not World War II. Instead, it’s the Paraguayan War of 1864–70. In that war, 30 soldiers died for every 1,000 citizens of the countries involved. It’s even worse if we also consider civilian deaths; while estimates are very uncertain, it’s plausible that about half of the men in Paraguay, or around a quarter of the entire population, was killed.31 What if instead we compared wars by the proportion of the global population killed? World War II is again the worst conflict since 1816 on this measure, having killed about 3% of the global population. Going further back in time, though, we can find worse wars. Ghengis Khan’s conquests likely killed about 9.5% of people in the world at the time. The heavy tail means that some wars will be shockingly large.32 The scale of World War I and World War II took people by surprise, including the leaders who initiated it. It’s also hard to know exactly how big wars could get. We haven’t seen many really large wars. So while we know there’s a heavy tail of potential outcomes, we don’t know what that tail looks like. That said, there are a few reasons to think that wars much worse than World War II are possible: We’re statistically unlikely to have brushed up against the end of the tail, even if the tail has an upper bound. Other wars have been deadlier on a per-capita basis. So unless wars involving countries with larger populations are systematically less intense, we should expect to see more intense wars involving as many people as World War II. Economic growth and technological progress are continually increasing humanity’s war-making capacity. This means that, once a war has started, we’re at greater risk of extremely bad outcomes than we were in the past. So how bad could it get? How bad could a modern great power war be? Over time, two related factors have greatly increased humanity’s capacity to make war. 33 First, scientific progress has led to the invention of more powerful weapons and improved military efficiency. Second, economic growth has allowed states to build larger armies and arsenals. Since World War II, the world economy has grown by a factor of more than 10 in real terms; the number of nuclear weapons in the world has grown from basically none to more than 9,000, and we’ve invented drones, missiles, satellites, and advanced planes, ships, and submarines.

<<LINE BREAKS CONTINUE>>

Ghengis Khan’s conquests killed about 10% of the world, but this took place over the course of two decades. Today that proportion may be killed in a matter of hours. First, nuclear weapons could be used. Today there are around 10,000 nuclear warheads globally.34 At the peak of nuclear competition between the United States and the USSR, though, there were 64,000. If arms control agreements break down and competition resurges among two or even three great powers, nuclear arsenals could expand. In fact, China’s arsenal is very likely to grow — though by how much remains uncertain. Many of the nuclear weapons in the arsenals of the great powers today are at least 10 times more powerful than the atomic bombs used in World War II.35 Should these weapons be used, the consequences would be catastrophic. Graph showing that early nuclear weapons are 1,000s of times more explosive than previous conventional explosives Source: AI Impacts, Effect of nuclear weapons on historic trends in explosives

By any measure, **such** a **war** would be **by far** the **most destructive**, **dangerous event** in **human history**, with the potential to cause billions of deaths.

The probability that it would, on its own, lead to **humanity’s extinction** or unrecoverable **collapse**, is contested. But there seems to be some possibility — whether through a **famine** caused by **nuclear winter**, or by reducing **humanity’s resilience** enough that **something else**, like a **catastrophic pandemic**, would be far **more likely** to reach **extinction**-levels (read more in our problem profile on nuclear war).

**Nuclear weapons** are **complemented** and **amplified** by a **variety** of other **modern military** technologies, including **improved missiles**, **planes**, **submarines**, and **satellites**. They are **also not** the only **military technology** with the **potential** to cause a **global catastrophe** — **bioweapons**, too, have the potential to cause massive harm through accidents or unexpected effects.

**Independently, The Air Force is key to Humanitarian Aid, saves millions.**

**Brading 16** [Tom Brading, senior airmen for 315th air wing "701st makes humanitarian aid possible in Haiti", April 21, 2016, Air Force Reserve Command, https://www.afrc.af.mil/News/Article/742620/701st-makes-humanitarian-aid-possible-in-haiti/, Accessed March 29, 2025] ejs squad

Members from **the** 701st Airlift Squadron played a vital role bringing humanitarian aid to Port-au-Prince, Haiti, April 21, during ongoing **Denton Program** efforts. Two C-17 Globemaster III’s were filled with 32 combined pallets and d**elivered more than 170,000 pounds of humanitarian aid to Haiti**. “Our role in the Denton mission is supporting the delivery of the cargo and supplies,” said Capt. Ed Sutton, 701st AS pilot. “It’s a rewarding experience to be a part of relief efforts to areas like Haiti or anywhere else in the world that may need it.” The Denton Program creates an opportunity for private organizations to utilize space available on U.S. Military cargo aircraft to **transport goods to countries in need**. The cargo moved under the Denton Program generally includes medical supplies, education supplies, furniture, vehicles, agricultural supplies, machinery, and clothing to support ongoing relief efforts and development projects. The supplies delivered by the 701st AS will be used by nongovernmental organizations throughout Haiti. Although Haiti is a developing country, it has experienced its share of disasters. Currently, 1.5 million Haitians are threatened with malnutrition, double the estimated number last year, due to a three-year drought in the Caribbean region. “Crops are being lost, rivers have dried, and children from villages in the mountains are being left unattended in Port-au-Prince, because their parents believe the children’s survival is greater in the city alone than with them in dry rural areas,” said Pacius Gueston, Haiti Christian Developmental Project director. “**This aid will save** many lives.” Orphaned as a child, Gueston was raised by a nun in Haiti and taught the importance of education and work ethic. After attending college in the United States, he returned to Haiti to give back to the people that needed support. Today, 70 percent of the estimated crops on the Caribbean island have been lost due to an ongoing drought, creating food instability for more than **3.6 million individuals.** With farming being the primary source of income for the Haitians, the drought has created more financial instability. Kathy Cadden, president and founder of Operation Ukraine, is another face on the ground in Haiti welcoming service members, like the 701st AS, during the offload of humanitarian supplies. She has been active in humanitarian efforts in the country. Half of this Denton cargo delivery was for her charity. “We’ll make great use of the donated food and supplies,” said Cadden, who estimates she’ll oversee more than 8,500 dry meals and 3,500 cooked meals to be made for children. “We’re very thankful for everything the donor’s and the military has done.” Since 1998, **The Denton Program has overseen more than 5 million pounds of humanitarian supplies sent to more than 50 countries across the globe.**

**In fact, Gen AI is good for education AND critical thinking**

**Meta-study proves AI improves test scores significantly**

Sun, L., & **Zhou**, L. (20**24**). School of Education, Minzu University of China, Beijing, China. Does Generative Artificial Intelligence Improve the Academic Achievement of College Students? A Meta-Analysis. Journal of Educational Computing Research, 62(7), 1896-1933. <https://doi.org/10.1177/07356331241277937>//ejs squad

**The use of generative artificial intelligence (Gen-AI) to assist college students in their studies has become a trend**. However, there is no academic consensus on whether **Gen-AI can enhance the academic achievement of college students**. Using a **meta-analytic approach,** this study aims to investigate the effectiveness **of Gen-AI in improving the academic achievement of college students and to explore the effects of different moderating variables. A total of 28 articles (65 independent studies, 1909 participants) met the inclusion criteria for this study.** The results showed that **Gen-AI significantly improved college students’ academic achievement** with a medium effect size (Hedges’s g = 0.533, 95% CI [0.408,0.659], p < .05). There were within-group differences in the three moderator variables, activity categories, sample size, and generated content, when the generated content was text (g = 0.554, p < .05), and sample size of 21–40 (g = 0.776, p < .05), the use of independent learning styles (g = 0.600, p < .05) had the most significant improvement in college student’s academic achievement. The intervention duration, the discipline types, and the assessment tools also had a moderate positive impact on college students’ academic achievement, but there were no significant within-group differences in any of the moderating variables. This study provides a theoretical basis and empirical evidence for the scientific application of Gen-AI and the development of educational technology policy.

**Ai key to fight misinfo**

Christine **Clark** 24, 9-17-20**24**, [], "How AI Can Help Stop the Spread of Misinformation", No Publication, https://today.ucsd.edu/story/how-ai-can-help-stop-the-spread-of-misinformation, 3-6-2025 (Researcher at the University of California San Diego) //ejs squad

**Machine learning algorithms significantly outperform human judgment in detecting lying during high-stakes strategic interactions**, according to new research from the University of California San Diego’s Rady School of Management. The study can have **major implications for the spread of misinformation, as machine learning could be used to bolster efforts to reduce fictitious content on major platforms like YouTube, Tik-Tok and Instagram.**

The paper, to be published in Management Science, focused on participants’ ability to detect lying on the popular British TV show “Golden Balls,” which aired from 2007 to 2010. It finds that while humans struggle to predict contestants' deception behavior, algorithms perform much better.

“We find that **there are certain ‘tells’ when a person is being deceptive**,” said Marta Serra-Garcia, lead author of the study and associate professor of behavioral economics at the UC San Diego Rady School of Management. “For example, if someone is happier, they are telling the truth and there are other visual, verbal, vocal cues that we as humans are share when we are being honest and telling the truth. Algorithms work better at uncovering these correlations.”

The algorithms used in the research achieved an impressive accuracy rate, correctly predicting contestant behavior 74% of the time, compared to the 51%-53% accuracy rate achieved by the more than 600 humans who participated in the study.

In addition to comparing machine learning and human abilities to detect deception, the study also tested how algorithms could be leveraged to help people better tell apart those who lie and those who tell the truth.

In one experiment, two different groups of study participants watched the same set of “Golden Balls” episodes. One group had the videos flagged by machine learning before they viewed them. The flags indicated that the algorithm predicted the contestant was most likely lying. Another group watched the same video and after they viewed it, they were told the algorithm flagged the video for deception. Participants were much more likely to trust the machine learnings’ insights and better predict lying, if they got the flag message before watching the video.

“Timing is crucial when it comes to the adoption of algorithmic advice,” said Serra-Garcia. “Our findings **show that participants are far more likely to rely on algorithmic insights when these are presented early in the decision-making process.** This has particular importance for online platforms like YouTube and TikTok, which can use algorithms to flag potentially deceptive content.”

Coauthor Uri Gneezy, professor of behavioral economics at the Rady School added, “Our study suggests that these **online platforms could improve the effectiveness of their flagging systems by presenting algorithmic warnings before users engage with the content, rather than after, which could lead to misinformation spreading less rapidly.”**

Some of these social media websites are already using algorithms to detect suspicious content, but in many cases, a video has to be reported by a user and then investigated by staff who can flag the content or take it down. These processes can be drawn out, as employees at tech companies like TikTok get overburdened with investigations.

The authors conclude, “Our study shows how technology can enhance human decision making and it’s an example of how humans can interact with AI when **AI can be helpful**. We hope the findings can help organizations and platforms better design and deploy machine learning tools, especially in situations where accurate decision-making is critical.”

**The U.S has had LAWs for decades—there is no brink.**

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www.atlanticcouncil.org/blogs/new-atlanticist/autonomous-weapons-are-the-moral-choice/. Accessed 7 Mar. 2025. //ejs squad

Fully autonomous weapons are not only **inevitable**; they **have been** in the United States’ **inventory** since at least **1979**, when it fielded the **Captor Anti-Submarine Mine**, which held a torpedo anchored on the bottom that launched when onboard sensors confirmed a designated target was in range. Today,the United States holds a **significant inventory** of **Quickstrike smart sea mines** that, when activated, autonomously select their targets using onboard sensors. The US Navy’s Mark 48 ADCAP torpedo can operate with or without wire guidance, and it can use active and/or passive homing. In fact, the fastest-growing segment of the torpedo market is for autonomous torpedoes. **Autonomous anti-ship cruise missiles** have been developed and fielded. **Modern air-to-air missiles** can lock

on a target after launch. More than ten nations operate the Israeli-developed Harpy, a fully autonomous drone that is programmed before launch to fly to a specified area and then hunt for a class of targets using electromagnetic sensors. The follow-on system, Harop, adds visual and infrared sensors. Harop was only the first of a rapidly growing family of weapons known as loitering munitions. These munitions are designed to “loiter” over a battlefield until they can identify a target and then strike it. While many such munitions still require a human operator to select a target, they are essentially a software upgrade away from autonomy. And, of course, **victim-initiated mines**(the kind one steps on or runs into) have been around for well over a century. These mines are essentially **autonomous**. They are unattended weapons that kill humans without another human making that decision.Despite strong international opposition and the Ottawa Convention or Anti-Personnel Mine Treaty, **anti-personnel mines** are **still in use**. But even these primitive weapons are really “human starts the loop” weapons. A human designed the detonators to require a certain amount of weight to activate the mine. A human selected where to place them based on an estimation of the likelihood they will kill or maim the right humans. But once they are in place, they are fully autonomous. Thus, much like current autonomous weapons, a human sets the initial conditions and then allows the weapon to function automatically. The key difference between the traditional automatic mine and a smart, autonomous mine, like the Quickstrike, is that the smart mine attempts to discriminate between combatants and noncombatants. Dumb mines do not. Thus, it is fair to assume that smart mines are inherently **less likely** to **hurt** noncombatants than older mines. In short, arguments about whether democratic nations should field and employ LAWS miss the point. They have used autonomous weapons for decades—in multiple domains and in large numbers. Further complicating the picture, current arguments against autonomous weapons are primarily based on the multi-decade US use of drones to hunt and kill individuals. These missions developed over days or even weeks with operators closely controlling each drone. Analysts had time to evaluate each mission and provide advice to senior officers, who then made the final decision, and usually after consulting with lawyers. During this period, it was both reasonable and ethical to refuse to use LAWS. It will continue to be right to refuse to employ LAWS under these conditions. However, the Ukrainian conflict reveals a rapid, major change in the character of how war is fought. Both sides are using hundreds of drones at a time. Their routine use has been an essential element in Ukraine’s ability to hold its own against larger Russian forces. Further, the use of drones is increasing at an almost exponential rate. Ukraine ordered two hundred thousand drones to be delivered during 2023 and has trained ten thousand drone pilots to date. In response, both sides are very active in counter-drone electronic warfare (EW). To defeat Russian EW efforts, Ukraine is combining tactics and technology. Tactically, they are flying lower and seeking gaps in Russian EW coverage. They are also pursuing technology to increase autonomy in existing drones. The logical conclusion of this counter-measure process is full autonomy. Autonomous drones will not have the vulnerable radio link to pilots, nor will they need GPS guidance. Autonomy will also vastly increase the number of drones that can be employed at one time. Both the Harpy and the Shahed drones have demonstrated that it is possible to rapidly launch large numbers from trucks or containers. The era of the autonomous drone swarm has begun.

**LAWs are developed but NOT deployed due to technological limitations and countermeasures --- prefer a Harvard policy brief > tech optimists.**

**Miller 21** [Steven E. Miller, Director of the International Security Program @ Harvard Kennedy School Belfer Center for Science and International Affairs, 3-10-2021, Nuclear Hotlines: Origins, Evolution, Applications, Journal for Peace and Nuclear Disarmament,<https://www.tandfonline.com/doi/full/10.1080/25751654.2021.1903763#abstract>, //ejs squad]

Key Assessments:

The fully autonomous weapon systems envisioned for the defense of Taiwan are at least five years away from operational maturity and fielding. The research, development, and operational testing of advanced AI models and hardware needed for autonomous weapon systems have advanced significantly over the past several years. But, similar to the commercial development of autonomous vehicles, technology optimists often underestimate the technological and operational challenges of fielding fully autonomous weapon systems.

The United States is unlikely to utilize fully autonomous weapon systems against China’s most likely strategy: a blockade of Taiwan. Given the risk of escalation and the inherent lack of transparency in advanced AI models, senior policymakers will likely limit the use of autonomous weapon systems in a blockade scenario to missions such as intelligence collection or the deployment of advanced smart mines.

Recent advances in counter-drone technologies will likely limit the efficacy of attritable semi-autonomous weapons and increase the urgency of developing fully autonomous weapons. Since late summer of 2024, the overall efficacy of autonomous platforms on the battlefield in Ukraine has diminished because of increasingly effective counter-UAV capabilities, including electronic warfare and GPS spoofing. Similarly, China’s network of defensive capabilities, including anti-aircraft guns, directed energy, and jamming systems, would limit the efficacy of U.S. autonomous weapon systems in a conflict.

Replicator will fuel the U.S.-China security dilemma in the context of autonomous weapon systems. The U.S. fielding of autonomous weapon systems will likely stoke the production and fielding of autonomous platforms and defensive systems, or precipitate an arms race in autonomous weapons systems. This dynamic could ultimately favor Beijing due to its industrial capacity, strength in commercial drone manufacturing, lower production costs, and consistent disregard for international law.

Senior military leaders must continue to develop and exercise realistic, sophisticated concepts of operations for autonomous weapon systems that are fully integrated into any formal military plans for the defense of Taiwan. These plans will both drive operational innovation and bolster the requirements process necessary for the sustainable fielding of autonomous weapon systems. Without detailed concepts of operations, the production and fielding of autonomous weapon systems may stall.

The Department of Defense should prioritize accuracy and traceability over explainability due to the “black box” trade-off. Ideally, AI models for autonomous weapon systems would provide explanations for their decisions, but the advanced deep learning algorithms necessary for fully autonomous weapon systems are too complex to offer semantic explanations understandable to humans. Given these constraints, traceability and accuracy must take priority over explainability to ensure that autonomous weapon systems are effective in combat and comply with the law of armed conflict.

Limited real-world data will require the Department of Defense to manage the risk of using synthetic data for the development of fully autonomous weapon systems’ advanced AI models. The Department of Defense must continue to identify and gather the data necessary to develop underlying AI models for autonomous weapon systems. However, limited real-world intelligence data from PLA exercises is not sufficient to train autonomous weapon systems for large-scale conflicts in the defense of Taiwan. Generative Adversarial Network models are useful for creating comprehensive synthetic environments to train autonomous weapon systems, refine the underlying AI model and its ability to identify targets, detect anomalies during missions, and navigate complex terrain.

Fielding fully autonomous weapon systems will require advancements in battery and edge computing technologies. Due to the challenges of exchanging information with cloud computing resources in denied electronic environments, autonomous weapon systems must utilize parallel computing on the edge. The advanced AI models used in autonomous weapon systems will also come with other limitations and drawbacks, such as high energy use, compelling developers to make trade-offs between speed, efficiency, and performance.

The Department of Defense’s interpretation of international law will be embedded in the AI algorithms for fully autonomous weapon systems, effectively serving as a codification of the United States’ approach to the laws of war. Fully autonomous weapon systems operating in denied electronic environments will need to independently interpret and apply the law of armed conflict, maritime legal regimes, and rules of engagement. The training process for autonomous weapon systems’ AI models in these scenarios would represent the codification of the U.S. interpretation of the law. To ensure that fully autonomous weapon systems operating without direct human oversight can reasonably interpret the law of armed conflict, the Department of Defense should assemble a team of experienced targeting specialists, military lawyers, scientists, and engineers to comprehensively incorporate legal training into AI model development.