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CONTESTED DECENTRALIZED MOBILIZATION

**DECISIVE
POINT
2035**



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About This Document

The United States Army War College (USAWC) student team Decision Point 2035 prepared this document as a group Integrated Research Project, contributing to team members earning a Master of Strategic Studies degree from the USAWC. This product's research, analysis, and production occurred over 28 weeks from October 2022 to April 2023 as part of the in-residence USAWC Senior Service College program. The team consisted of 5 U.S. Army Officers. The team members were LTC Robert (Bob) McTighe, LTC Michael Mignano, COL John C. Haas, Jr., COL Robert “Bobby” Shadowens, and COL Keith Vanyo. The team conducted the research under the direction of Professor Kathleen Moore, Ph.D., Professor of Data Science, Center for Strategic Landpower and Futures Group, USAWC.

Research Question

How can the United States Army Reserve optimize the mobilization process to support large-scale combat operations in 2035?

- Describe the mobilization environment in 2035.
- How does the enterprise optimize the pre-mobilization readiness level?
- What is required to maintain/build cohesive teams?
- What is required to leverage individual skills?
- What is required to optimize mobilization certification?
- What cultural obstacles will prevent the optimization of the mobilization process?

Terms of Analytic Probability

Team members used the Kesselman List of Estimated Words (Annex D) to define terms of analytic probability. Using this scale, team members provided an estimate for each analytical report in this document to forecast the probability that a particular claim would occur.

Certainty 100%		 Likelihood
Almost Certain	86 – 99%	
Highly Likely	71 – 85%	
Likely	56 – 70%	
Chances a Little Better (or Less)	46 – 55%	
Unlikely	31 – 45%	
Highly Unlikely	16 – 30%	
Remote	01 – 15%	
Impossibility 0%		

Figure 1: Kesselman List of Estimated Words

Source Reliability

Team members noted each source with a hyperlink that described the reliability as Low (L), Moderate (M), or High (H). Team members determined source reliability using the Trust Scale and Web Site Evaluation Worksheet (Annex C).

Analytic Confidence

The overall analytic confidence of this estimate is moderate. The questions asked were complex, and the timeline was relatively short due to the competing academic requirements of the USAWC core curriculum. Source reliability and corroboration were predominantly moderate to high. However, the analysts were not subject matter experts and worked individually and collaboratively to research and answer the questions. Theoretical predictions varied, and research sometimes conflicted, specifically with time-based predictions on technical reliability or wide-scale adoption. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Report Organization

This report is available in PDF and hard copy formats, with the PDF version including links to the source materials. The main body contains five sections: Future Mobilization Environment, Building and Maintaining Cohesive Teams, Synthetic Training, Optimized Logistics, and Additional Finding. On April 26, 2023, Decision Point 2035 briefed MG LeBoeuf on the key findings (Annex G).

Key Findings

United States Army Reserve (USAR) is highly likely to optimize the mobilization process to support large-scale combat operations in 2035 by leveraging technological advances and implementing decentralized mobilization. Despite technological improvements such as extended reality (XR) systems, collaborative platforms, and artificial intelligence, USAR requires significant procedural and cultural shifts to execute this novel approach.

The Mobilization Environment of 2035

Progressive advancements in technology, geopolitical shifts, and emerging threats will highly likely characterize the U.S. mobilization environment in 2035. A resilient homeland will enable a high level of readiness to rapidly deploy forces to any region of the world. The proliferation of advanced technologies is likely to lead to the democratization of warfare, with non-state actors possessing advanced capabilities that threaten national security. Anticipating complete freedom of movement, unhindered transportation to embarkation ports, and uncontested deployment against the country's enemies are unreasonable. In addition to cyber, space, and information domain dilemmas, Mobilization Force Generation Installations (MFGI) present a desirable target for kinetic strikes. Decentralized mobilizations from unit home stations will highly likely support rapid mobilization and provide superior force protection.

Building Future Teams and Leveraging Individual Skills

XR and Talent Management Artificial Intelligence (TMAI) will likely be the tools that enable the USAR to build and maintain cohesive teams that leverage individual skills. XR will likely negate the often-thought-of handicap of physical distance for building cohesive teams, and TMAI will exploit it. Advancement, promulgation, and convergence of XR technologies will nullify the physical distance of disbursed teams and allow users to connect personally and train in groups regardless of where they live. The ability to build teams across a widely physically distributed population will highly likely allow TMAI to produce more tailored organizations with unique skill sets because it will have a larger population to pull from.

The education, commercial retail, industrial training, and gaming industries rapidly advance and promulgate XR technology through daily exposure. Competition between major commercial corporations is driving the technology to become more realistic, cheaper, and accessible to a broader audience. Haptic devices use multiple energy forms to create tactile experiences such as ultrasonics, heat, force feedback, water pressure, air pressure, and transcutaneous electrical nerve stimulation. The convergence of haptic technology with XR will enable an immersive experience, allowing users to interact physically with their virtual environment.

Unconstrained by physical distance, TMAI will create teams by recruiting specific candidates and identifying the right talent based on individuals' skills and psychological profiles. The technology enables supervisors to conduct employee performance evaluations, remove psychological prejudice, and assist in identifying individual team member training needs by focusing on factual-unbiased data. TMAI will also stitch together patterns and trends in performance data from multiple sources so leaders can make informed decisions and boost group performance.

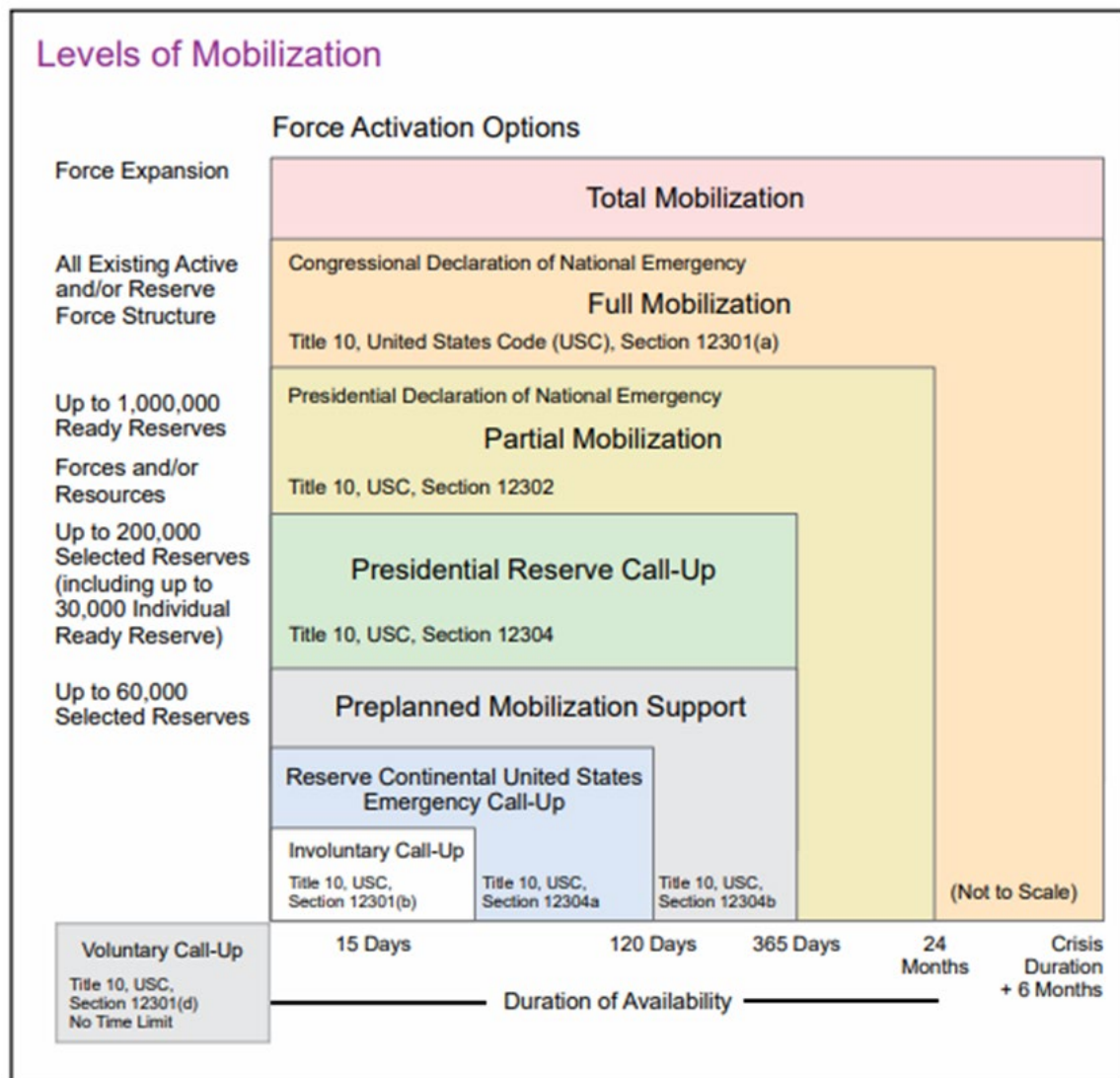


Figure 2: Current levels of mobilization according to the U.S. code

Mobilization Enterprise: Optimizing the Process

Training

Through significant resource investments, the United States Army is creating a Synthetic Training Environment (STE) that uses Extended Reality (XR), Artificial Intelligence (AI), and Massive Open Online Courses (MOOCs) for individual and collective training. By 2035, components and systems associated with synthetic training will highly likely evolve to a near real-life replication level that yields efficiency and cost savings. Moreover, the contested nature of a future full-scale mobilization necessitates a rapid and decentralized approach. Where a standard USAR mobilization of 2023 requires approximately 13 months of pre and post-mobilization training, a future decentralized mobilization can highly likely occur in less than a month. Soldiers execute individual training using MOOCs and the STE before mobilization. They can perform real-life training at their home of record using a future version of the Integrated Visual Augmentation System (IVAS). Gamification techniques and compensation will likely incentivize individual training and ensure required readiness levels. Approximately two weeks after notification of sourcing, the deploying unit can aggregate at their designated home station. A mobile STE training team will likely facilitate pre-deployment collective tasks and execute a culminating training event. This approach is highly likely to alleviate the need for the Mobilization Force Generation Installation (MFGI).

Personnel

Over the next decade, collaborative AI and telemedicine advancements will highly likely facilitate a decentralized Soldier Readiness Process (SRP). Integrating administrative and medical tasks will almost certainly enable a more efficient and streamlined process by leveraging AI, collaboration tools, and XR. AI will compile and analyze troop readiness and operational capabilities data, streamlining the process and increasing efficiency. It is highly likely that USAR personnel can conduct most of the administrative and medical tasks associated with SRP before receiving sourcing notification or during the two-week lead-up period prior to the unit's home station mobilization. AI will forecast health trends and identify potential health hazards among troops, reducing the administrative burden on medical professionals.



Figure 3: Notional Training Approach

Mobilization Concept

"Think, Act, Operate Differently"

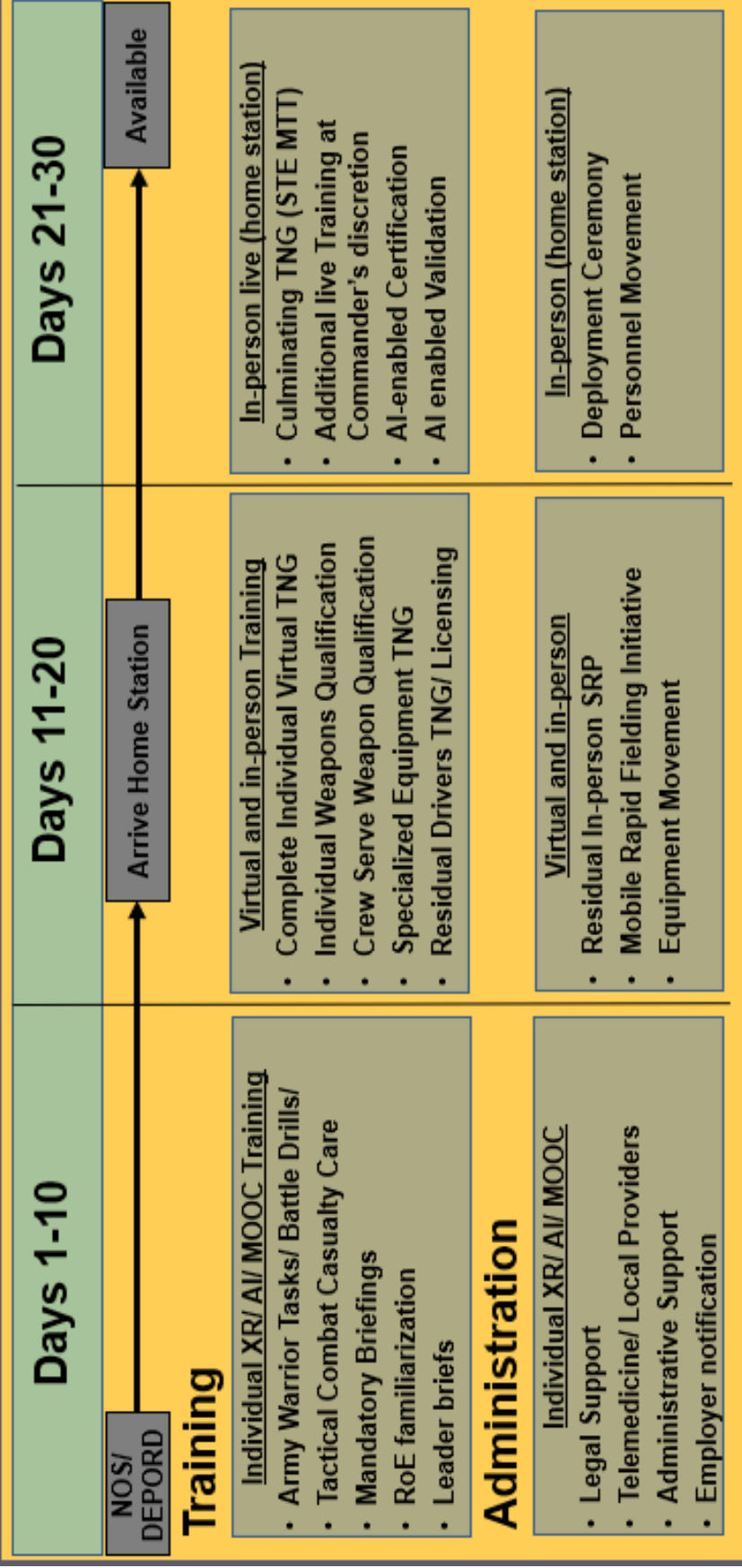


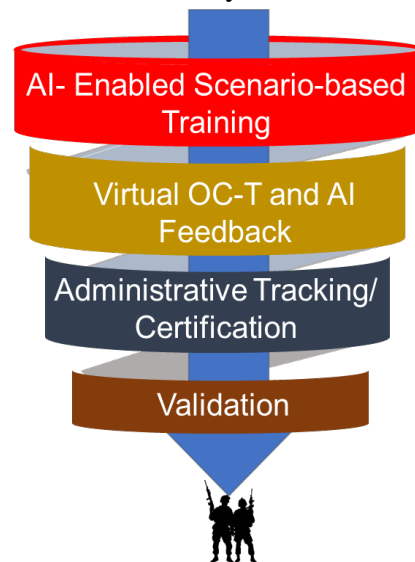
Figure 4: Modified Home Station Mobilization

Equipping

STE and AI-enhanced logistics will highly likely reduce the nation's transportation infrastructure burden and facilitate military equipment positioning. This technology will fundamentally alter Army mobilization by delivering material to future debarkation ports via autonomous trucks, trains, planes, and ships. In a decentralized mobilization, the movement of equipment will highly likely occur from dispersed points of origin, reducing targeting risk and streamlining throughput. Moreover, the novel STE approach will likely allow soldiers to train without organic equipment, systems, and platforms, creating opportunities for early equipment pre-positioning IAW, the Regionally Aligned Readiness and Modernization Model (ReARMM).

Optimization of Mobilization Certification and Validation

Future training certification and validation will move from physical observations and detailed analog record-keeping to a streamlined and decentralized commander-driven process using AI and digital collaboration tools. Additionally, XR will enhance the certification process allowing the Observer, Controller, and Trainers (OC-T) to utilize the same virtual tools as the training audience. In the future, virtual OC-Ts will identify training deficiencies through AI-enabled feedback and provide coaching to bring participants to an acceptable standard. By combining collaborative tracking tools with virtual trainers and AI-enabled feedback, the certification of individual and collective training tasks will highly likely become more efficient and streamlined.



Fully Trained, Certified, Validated Soldiers

Cultural Obstacles to Decentralized Mobilization

The Army's organizational culture is almost certain to resist the shift to decentralized mobilization due to a range of factors. One significant challenge is the need for remote validation of troops, which may be difficult to achieve without sacrificing the level of training and readiness required for successful missions. Another obstacle is the potential reduction of live training opportunities, which could limit soldiers' ability to acquire the skills and experience necessary for effective combat. Additionally, there may be a low level of trust in AI and its ability to support military operations. Despite these challenges, the Army recognizes the importance of live training and seeks to maintain its emphasis on this

critical component of combat readiness. The transition will have three obstacles to overcome: remote validation, reduction of live training, and low trust in AI.

Remote validation

The current mobilization process is an eight-step process (*see Figure*) that has not changed in the last three decades. In 2009, the Army issued Execution Order 150-08, defining that First Army is responsible for executing training and readiness oversight authorities over Reserve Component forces and validating units ready for deployment. The decentralized mobilization model will eliminate the movement to and training at the mobilization station and streamline the validation process. However, it will require First Army to simultaneously organize its support to multiple sites.

Reduction of Live Training

Decentralized mobilization will highly likely reduce or, in some instances, eliminate live training from the mobilization process. Army Field Manual 7-0 (Training) established live training as integral to mobilization readiness. Leaders consider live training the most effective way to generate confidence and trust among leaders, teammates, and Soldiers. Reducing Live training will be a drastic change for leaders to accept. As STE technology improves, it will likely prove to be a sufficient substitute for live training and meet the minimum military requirement for pre-deployment certification and validation.

Low Trust in AI

The lack of trust in AI is a complex issue influenced by several factors. One primary reason is that the public has limited experience and knowledge about the technology, leading to concerns about unintended consequences arising from machine learning. Lack of transparency and potential prejudice in the data that the associated algorithms used to learn exacerbate user apprehension. The transparency issue is related to the difficulty in comprehending how models arrive at decisions since they may identify patterns that are not apparent to humans, resulting in unpredictable behavior and medium perplexity. Moreover, the effectiveness of AI solutions is heavily reliant on the algorithms used to train them. A notable example of this is Amazon's recruiting engine, which unintentionally learned to prefer male applicants based on historical hiring data and excluded female candidates, revealing how biases can be inadvertently perpetuated by poor algorithmic design.

Table of Contents

About This Document.....	1
Key Findings.....	3
Table of Contents	9
Future Mobilization Environment.....	11
In the Next Major Conflict, Contested Mobilization Will Highly Likely Require Decentralized Operations.....	12
The United States Army Will Likely Adapt To Small, Tailored Units Across A Large Area Of Operations	15
Artificial Intelligence will Highly Likely Change the Character of Warfare by 2035	18
U.S. Forces Will Almost Certainly Face A Contested Mobilization Environment At Its Seaports In Future Conflicts	20
Empowerment of Violent Extremist Organizations from the Proliferation of Technology Will Alter Irregular Warfare	22
Building And Maintaining Cohesive Teams.....	24
XR and TMAI Will Likely Be The Tools To Build Cohesive Teams Of The Future Over The Next Decade.....	25
Advances In Collaboration Tools Highly Likely To Enable Decentralized And Asynchronous Teams Within 5-10 Years	27
Hybrid Workplace Will Likely Dominate The 2035 Workforce.....	29
Talent Management AI Will Highly Likely Increase Work Performance In Ten Years	32
Significant Recruiting Challenges in U.S Army Reserves Highly Likely Within 15-20 Years	34
Americans Will Mass in Southern Suburban Metro Areas Regardless of Increased Risk of Natural Disasters.....	37
Advances in Technology Will Highly Likely Prepare Commercial Enterprises to Compete in a Business Environment of the Future	39
Advances in Virtual Reality Will Highly Likely Revolutionize How Dispersed Teams Collaborate in the Next Ten Years.....	42
Synthetic Training.....	45
Synthetic Training Replicates Combat Environment And Is Likely To Replace In- Person Training By 2035	46
Gaming is Likely To Become the Primary Media For Learning Within The Next 5-10 Years	49
FEMA Will Highly Likely Be A Proactively Data-Driven Organization By 2035.....	52
Widespread AR/VR Familiarity Highly Likely Within Ten Years	54

Highly Likely that Crowdsourcing and Crowdfunding Will Enable Advanced Haptics Accessibility Over the Next Decade	56
Advances in Geographic Mapping for Virtual Environments Will Most Likely Support the Next Large-Scale Military Operation	59
Software Advancements Will Highly Likely Revolutionize Virtual Reality Training in the Next Decade	61
Data Requirements Will Highly Likely Transform Wireless Network Architecture Within The Next Ten Years	63
Optimized Logistics	65
USAR Is Highly Likely To Decentralize Premobilization Administrative and Medical Tasks Within the Next Ten Years	66
Artificial Intelligence and Machine Learning Will Synchronize Movements Enabling Future Mobilization	68
New Transportation Modes, Autonomous Vehicles, And Digital Passports Highly Likely To Expedite Travel Within Ten Years	70
The USAR Will Likely Have Fewer Soldiers to Deploy in Support of 2035 Worldwide Operations	72
Autonomous Technologies Will Likely Revolutionize Military Logistical Transportation Within 10-15 Years	74
Intelligent Technologies Will Highly Likely Transform How the U.S. Forest Service Mobilizes In The Next 10-15 Years.....	76
Additional Findings	78
USAR Will Highly Likely Face Significant Resistance As It Implements Decentralized Mobilization by 2035.....	79
Successful Proxy War In Ukraine Suggests Standard Mobilization Windows In Future Great Power Conflict	81
U.S. Mobilization Requiring Conscription Will Likely Result in Domestic Unrest ...	83
Annexes.....	85
Annex A: Terms of Reference.....	86
Annex B - Friedman Corollaries	90
Annex C – Standard Primary Source Trust Scale	91
Annex D – Words of Estimated Probability	92
Annex E – Mind Map	93
Annex F - Expert Interview Notes	94
Annex G – PowerPoint Slides.....	104

Future Mobilization Environment

In the Next Major Conflict, Contested Mobilization Will Highly Likely Require Decentralized Operations

Executive Summary

In the next major conflict, contested mobilization will highly likely (71-85%) require decentralized operations due to the changing character of warfare, the adversary's proliferation of technology, and the dependency on collaboration tools for all-domain operations. The increasing complexity of modern warfare, with the integration of new technologies and domains, demands a more agile and flexible approach to operations. Despite disrupted communication, coordination issues, and logistical challenges with decentralized operations by dispersing resources and capabilities across multiple domains, decentralized operations make it harder for adversaries to target and disrupt critical assets, improving operational resilience.

Discussion

The Joint Force will likely face multiple types of conflict, each requiring different capabilities, and may progressively lose the initiative to dictate strategic outcomes. [M](#) In addition to the operational environment's strategic ambiguity, the enemies' cyber, space, information, and even kinetic capabilities infer the homeland is no longer a sanctuary. [M](#) It is almost certain that U.S. forces will face a contested mobilization environment in future conflicts due to adversaries' multi-domain capability and hypersonic technology. [H](#) Possible conflicts could develop due to counterterrorism, gray-zone conflicts, asymmetrical wars, or high-end conflicts in the Indo-Pacific, Europe, or the Middle East, with the latter being the most likely. [M](#) Over the next decade, technological advancements in 6th generation communication, 3D printing, Artificial Intelligence (AI), and biotechnology will empower violent extremist organizations to impact the U.S. homeland. [H](#) The joint force will need patient, persistent, and culturally savvy capabilities to support integrated U.S. Government and partner irregular warfare efforts. [M](#) A full mobilization significantly strains the throughput on the Nation's mobilization infrastructure (highways, ports, rail) and will require a massive transportation effort. [H](#) In future conflicts, adversaries will almost certainly (86-99%) continue targeting transportation networks through the cyber and information domains. [H](#) Decentralization can reduce the time a joint force takes to mobilize, speeding up the overall mobilization process. [M](#)

Advancements in AI will transform warfare and increase the likelihood of its widespread use by 2035 as countries like China and Russia compete to develop and fund research, advanced technology, and enhanced capabilities. [H](#) Potential adversaries will likely operate from a distance and advancements in military precision, enhanced information warfare capabilities, and automation development due to AI's increasing prevalence. [M](#) Nation and non-nation states investing in simulations, Virtual Reality (VR), Augmented Reality (AR),

cognitive technologies, and mobile applications will likely adapt quickly to changing conditions and remain competitive. [H](#) As digital technologies accelerate and dependence on them deepens, the future conflict between actors will also increasingly involve elements of cyber conflict. [H](#) The proliferation of technology will drive evolution in irregular warfare, where dominance in information and understanding can prove decisive by increasing the speed, precision, and efficacy with which information shapes future conflicts. [H](#)

Improvements in Software as a Service (SaaS) technology, Massive Open Online Courses (MOOC), and enhanced smartphones can enable decentralized mobilization activities within the next ten years, allowing teams to collaborate synchronously and asynchronously through advances in collaboration tools. [H](#) Digital technology tools will highly likely become a crucial component of people's daily routines and decision-making. [M](#) In the next ten years, developments in autonomous technology will most likely transform logistical transportation and alter military sustainment due to autonomous trucks, warships, and drones. [H](#) Autonomous transportation systems can also help improve efficiency and safety in transportation operations, reducing the need for human intervention and enabling more decentralized decision-making. [M](#) In addition, Advances in AI and ML will almost certainly allow large-scale mobilization operations within the homeland, with enhanced automation and data analysis prioritizing military movements and facilitating whole-of-nation mobilization efforts. [H](#)

Decentralized operations can make it more difficult for adversaries to target and disrupt vital assets, ultimately improving operational resilience. However, they present communication disruptions, coordination problems, and logistical challenges due to the distribution of resources and capabilities across multiple domains. [M](#) [M](#)



Figure 5: CONUS Logistical Decentralized Operations

This approach can be beneficial in scenarios where centralized operations may be vulnerable to attacks, allowing for greater flexibility and adaptability in unexpected disruptions. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable, numerous, and corroborative. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst used artificial intelligence to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to innovation in capabilities and information.

Author: COL Robert J. Shadowens

The United States Army Will Likely Adapt To Small, Tailored Units Across A Large Area Of Operations

Executive Summary

The U.S. Army will likely (56 to 70%) adapt to small, tailored units spread across a large area of operations by 2030. This change is due to the adaptive nature of future enemies, a more complex environment, and the other services' development of the dispersed operations concept. Despite the Army's Multi-Domain Operations (MDO) guidance to disperse forces, the Army will likely need smaller, more flexible, and easier-to-disperse units.

Discussion

At the start of the Russian invasion of Ukraine, Russian forces quickly found and destroyed Ukrainian C2 nodes using unmanned aerial vehicles and electronic signature detection. [H](#) This war continues to show military leaders the value of long-range fires, as Ukraine targets and destroys concentrations of enemy personnel, equipment, and



Figure 6: Destroyed Russian Command Post

warehouses with weapons, ammunition, and fuel. [H](#) [M](#) Long-range fires and strikes mean that there is "no sanctuary in modern warfare" and that survivability depends on dispersing units, ammunition stocks, C2 nodes, maintenance areas, and aircraft. [H](#) [M](#) Any force fighting in 2030 or beyond must prepare for a very active campaign against the homeland (ports, airfields, bases, etc.) that could disrupt the ability to project power into the conflict. [H](#)

The USMC is adapting and transforming by organizing, training, and equipping its force into a smaller organization capable of dispersing through a large area of operation. [H](#) The USMC will emphasize innovation by providing units with cutting-edge technologies, including fifth-generation aircraft, next-generation ground vehicles, unmanned systems, cyber operations, space capabilities, and directed energy weapons." [H](#) The Marine 2030 force structure will emphasize a smaller, more capable, and lethal force. [H](#) According to the Office of the Director of National Intelligence's Intelligence Community: "The Marine

Corps Force of 2030 will focus on expeditionary operations with a combination of distributed operations, distributed lethality, and sea-basing capabilities. [H](#)

The USAF adopted the Agile Combat Employment (ACE) concept to enable the rapid deployment and employment of airpower [M](#) and identified ACE as a critical component of its strategy to maintain air dominance in the future. [M](#) The concept focuses on three main areas: agility, readiness, and lethality. [M](#) ACE includes small, decentralized operating bases and integrating new technologies, thus, increasing its agility, readiness, and lethality. [M](#)

The USN is also significantly changing its approach to combat operations with its Dispersed Operations (NDO) concept. NDO is a strategy that seeks to maximize the Navy's ability to disperse and operate independently of each other while still providing effective and coordinated support from larger forces. [M](#) This approach to combat operations involves using smaller and unmanned surface vessels to support larger ships making the USN more agile and responsive to potential threats. [M](#)



Figure 7: USNS Apalachicola: Navy's largest self-running craft

The USN is also leveraging distributed autonomous systems to deploy small units across a large area of operations. The USN has a prototype ship that can operate autonomously at sea for up to 30 days. [M](#) The 337-foot USN's Apalachicola is the 'USN's largest-ever self-running craft. [M](#) It is part of a

growing wave of drone planes and ships that could transform combat in the coming decades. [M](#) Additionally, these smaller vessels can gather intelligence, provide surveillance, and provide additional firepower to larger ships. [H](#)

Despite the Army's Multi-Domain Operations (MDO) doctrine stating that to survive and operate against massed long-range fires, commanders must ensure as much dispersion as tactically prudent. [H](#) The Army has not changed its force structure to support MDO; for example, the Army's current C2 nodes are large and stationary, with the concept of tearing it down and packing it quickly before an enemy attack. [H](#) [H](#) The Ukraine conflict shows that an adversary can target and destroy C2 nodes, proving a need to rethink C2 nodes. [H](#) [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ elicit.org) to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL John C. Haas, Jr.

Artificial Intelligence will Highly Likely Change the Character of Warfare by 2035

Executive Summary

Rapid advances in artificial intelligence (AI) will fundamentally change the character of warfare, making widespread military deployment highly likely (71-85%) by 2035. The hyper-competition in technology between the United States, China, and Russia has significantly increased budget requests for advanced technology and enhanced capabilities. Despite attempts by International Humanitarian Law (IHL) to limit the use of AI on military targets.

Discussion

In recent years AI research has significantly increased, and the use of this advanced technology in warfare will likely change the character of war. [M](#) As a result, the United States and other countries are investing heavily in and developing various AI applications for military purposes. [M](#) The Department of Defense's (DOD) increased spending in recent years reflects the increasing significance of AI. The most

recent DOD budget request allocated USD 130 billion for research and development to improve our readiness for cutting-edge technologies. [H](#) Both China and Russia have also made considerable investments in AI for their countries' national security. [H](#)

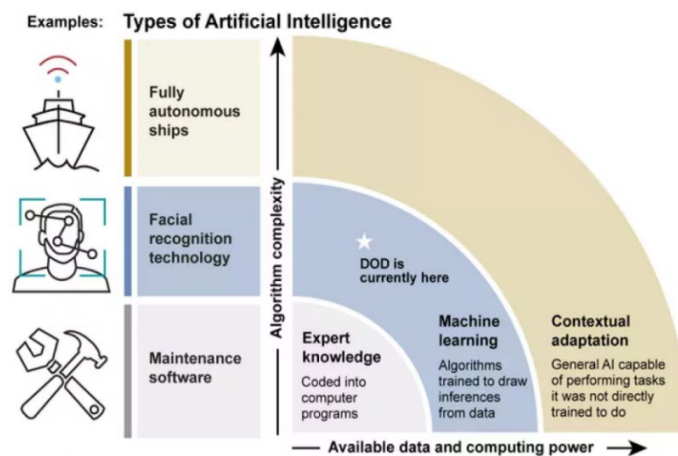


Figure 9 GAO analysis of information from DOD and academic experts.

The DOD reported that "AI is poised to transform every industry and is expected to impact every corner of the Department, spanning operations, training, sustainment, force protection, recruiting, healthcare, and many others." [H](#) Military experts are exploring many advanced capabilities to support future military missions. For instance, they are creating robotic ships and drones for the military, analyzing facial recognition information from intelligence sources, and recommending tactical missile attacks. [H](#) Many new advance weapon systems can operate autonomously, making decisions and carrying out actions without human intervention. [H](#) Autonomous systems will almost certainly play prominent roles in future conflicts due to their broad application to various tasks. [H](#) Autonomous

systems are enabling technologies that allow current platforms to operate in situations with fewer human interactions, longer operating times, and more dangerous environments. [H](#)

AI will highly likely improve Intelligence, Surveillance, and Reconnaissance (ISR) data and sensors to drive hypersonic weapons and other cutting-edge technologies to be more accurate and destructive. [H](#) Currently, delivering ISR data to end users requires enormous numbers with various formats, sources, and types. [M](#) Robert Cardillo, head of the National Geospatial-Intelligence Agency (NGA), stated that the current volume of full-motion video footage is only increasing. [H](#) He claimed that to carefully review all the data the NGA will gather over the next 20 years; over 8 million analysts will be needed. [H](#) AI-enabled ISR systems can solve this problem by interpreting massive amounts of data in real-time, providing military commanders with a much more precise and up-to-date picture of the battlefield. [M](#)

Many AI-enabled weapons, such as the Israeli Harpy loitering munition, can automatically search for and engage targets. [H](#) Nevertheless, programming lethal autonomous weapon systems to kill and leaving humans out of the loop poses risks. AI systems must be capable of distinguishing between military and civilian targets to adhere to international humanitarian law. [M](#) When there are no clear guidelines, it is challenging to instruct an AI system to avoid targeting noncombatants and civilian assets. [M](#) Despite this potential pushback, ineffective implementation and integration of AI technologies could jeopardize U.S. national security. [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to innovations in capabilities and information.

Author: COL Keith S. Vanyo

U.S. Forces Will Almost Certainly Face A Contested Mobilization Environment At Its Seaports In Future Conflicts

Executive Summary

U.S. forces will almost certainly (86-99%) face a contested mobilization environment in future conflicts due to the adversaries' ability to capitalize on aging infrastructure, seaport constraints, and cyber technology. Despite efforts to fortify critical infrastructure, logistical facilities, and communication networks against digital disruption, it may not be enough to prevent attacks.

Discussion

Experts expect the U.S. military to ship 90 percent of its cargo by sea during the next conflict, but there aren't enough ships to support a large-scale, rapid deployment. [M](#) [H](#) The Military Sealift Command's organic surge sealift fleet is critical for rapid response in a crisis or wartime scenario. [M](#) However, the average age of ships in the surge fleet is now 39 years, and due to various maintenance issues, less than 60 percent of sealift ships were able to activate during recently planned exercises. [M](#) Despite these obstacles, the



Figure 8: Sealift In Big Trouble

administration is only addressing bottleneck issues and plans to standardize data-sharing requirements for shipping lines, terminal operators, and cargo owners, but it does not address military seaports directly. [H](#) The Biden administration recently announced plans to invest billions of dollars in seaports. [H](#)

The U.S. relies heavily on seaports to project its military power. However, the current military port infrastructure is limited to only 22 strategic seaports. [M](#) Out of these, 17 seaports are commercial ports where the Department of Defense (DoD) ships alongside civilian commercial shipments. [M](#) Additionally, the Military Ocean Terminal Concord (MOTCO) and Military Ocean Terminal Sunny Point are critical West and East Coast military ports. [M](#) There are no suitable alternatives for large-scale coast deployment due to the nature and size of this mission, and MOTCO's infrastructure assets require critical upgrades and maintenance. [M](#) To increase flexibility, improve survivability, and reduce the impact risk to allied, partner,

and host nations, the Army must invest in more logistics over-the-shore (LOTS) capability in future operations, especially with limited or contested port facilities. [H](#)

The U.S. is a critical target for terrorist cyber attacks on personal, commercial, and government infrastructure. [H](#) Even though cybersecurity is a DoD-wide priority, logistical nodes are particularly vulnerable because most transportation data is stored and transmitted over the unsecured commercial internet, posing a significant risk to mission and information assurance. [H](#) Additionally, critical ship infrastructure like navigation, power, and cargo management are increasingly digitized and reliant on the Internet, making them vulnerable to cyber-attacks. [M](#) Cyberattacks on maritime transport increased by 400 percent in 2020, and cybersecurity risks are particularly problematic for ports because docked ship service providers network with shore-based operations. [M](#) According to U.S. national security and military officials, attackers are more daring and rapidly more sophisticated. [M](#) A Chinese state-owned company recently outfitted several American cargo ports with sophisticated sensors capable of registering and tracking the origin and destination of containers, posing a significant risk for future military mobilization. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ perplexity.ai) to visualize and scope the problem and reliable source information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Keith S. Vanyo

Empowerment of Violent Extremist Organizations from the Proliferation of Technology Will Alter Irregular Warfare

Executive Summary

Technology will highly likely (71–85%) empower violent extremist organizations (VEO) globally during the next ten years, changing the characteristics of warfare. Technology advancements in 6th Generation communication, 3D printing, Artificial Intelligence (AI), and biotechnology will likely increase access and capabilities for non-state actors by lowering entry barriers. Despite governance established by rules-based international order agreements, VEOs are unlikely to adhere to agreements negotiated between states and use the proliferation of technology to their advantage.

Discussion

Globalization, changing demographics, and weak conditions in underdeveloped regions internationally will continue to breed violent non-state actors. ^H Proliferation of technology will provide VEOs with new capabilities to achieve their agendas, changing the characters of irregular warfare. As digital technologies accelerate and dependence on them deepens, the future conflict between actors will also increasingly involve elements of cyber conflict. ^M The strategic defense guidance and intelligence assessments forecast ongoing irregular threats by non-state actors such as terrorists, insurgents, and transnational criminal networks increasingly empowered by technology. ^H Cyberspace is much easier to attack than to defend since attackers have multiple potential points of entry. ^M The United States will be at greater risk due to non-state actors and VEO continuing to gain access to new technologies.

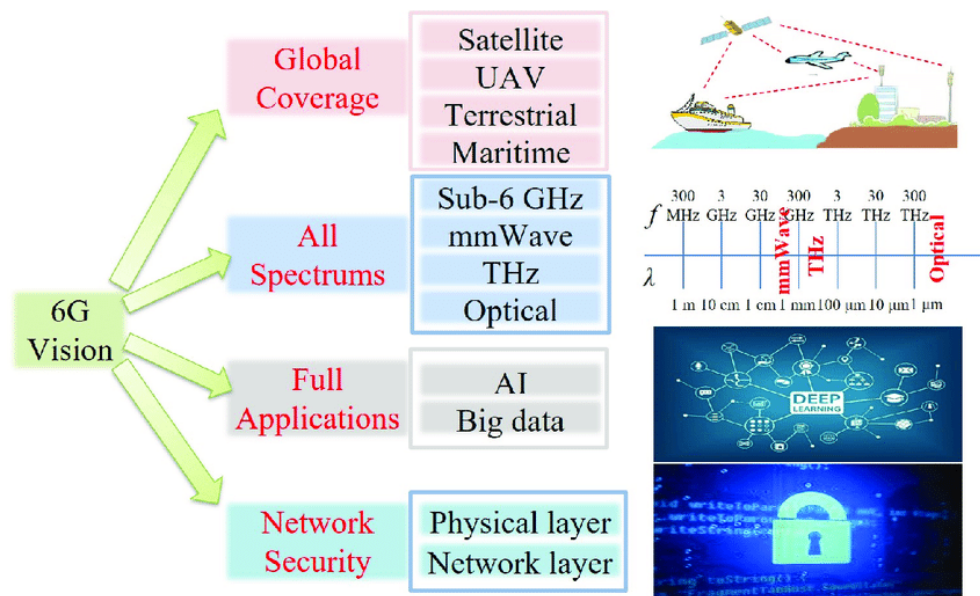


Figure 9: A vision of 6G wireless communication network

Mobile communication advancements will allow potential enemies widespread access to previously unattainable capabilities. Mobile communication takes about one decade from the initial concept research to the commercial deployment. [M](#) 6th Generation (6G) Communication is undergoing an unprecedented breakthrough and integrating traditional terrestrial mobile networks with emerging space, aerial and underwater networks to provide anytime, anywhere network access and deployed around 2030. [M](#)

The real revolution of 3D printing is less about the things you can make and more about where you make them. [M](#) 3D printing will be bigger, faster, and cheaper. 3D printing can assist the adversary in irregular warfare by allowing them to create gun barrels, bullets, artillery rounds, and other tools. [M](#) Low-cost drones that use off-the-shelf algorithms to sense and navigate are also proving a potent new weapon against more conventional systems and strategies. [M](#) It will be difficult to stop the spread of adversary capabilities through standard measures like arms embargoes and blockades as a result of 3D printing. [M](#)

In Ukraine, AI algorithms actively transcribe and interpret Russian radio chatter and identify Russian individuals in videos posted on social media using facial recognition tech. [M](#) AI-enabled technologies could become so powerful that they might obsolete traditional military power. [H](#) AI will drive evolution in irregular warfare, where dominance in information and understanding can prove decisive by increasing the speed, precision, and efficacy with which information shapes future conflicts. [H](#) The use of robotics will likely increase on the battlefield in parallel with the development of AI systems because of the evolution of AI rule-based algorithms. [M](#)

The global biotechnology market size has the potential to grow at a Compound Annual Growth Rate (CAGR) of 14 percent from 2022 to 2030. [M](#) Advances in biological research likely will permit the development of a new class of Advanced Biological Warfare (ABW) agents engineered to elicit novel effects. [M](#) Advances in biotechnology propose more aggressive capabilities to control and incapacitate enemy forces by creating weapons designed to manipulate the genes of the enemy. [M](#) The broad implications of biotechnology have emerged over many decades and ultimately impact national security and individual warfighters. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable, numerous, and corroborative. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to innovation in capabilities and information.

Author: COL Robert J. Shadowens

Building And Maintaining Cohesive Teams

XR and TMAI Will Likely Be The Tools To Build Cohesive Teams Of The Future Over The Next Decade

Executive Summary

The future extended reality (XR) environment, coupled with talent management artificial intelligence (TMAI), will likely (71-85%) build cohesive teams due to wide availability of technology, realism of the virtual environment, and the ability to tailor teams. The XR environment is becoming more immersive and TMAI is exploring the best way to recruit talent and create teams based on their individuals' skills to increase team performance. XR will negate the handicap of physical distance, and TMAI will exploit it, thus reduces the traditional burdens distance places on team building.

Discussion

The XR environment is becoming more immersive through corporate competition and advances in haptics, allowing distant users to connect personally. The education, commercial retail, industrial training, and gaming industries are rapidly advancing and promulgating XR technology through daily exposure. [H](#) Competition between major corporations such as Google, Microsoft, IBM corporation, and Samsung is driving the technology to become more realistic, cheaper, and accessible to everyday users. ^{(MIGNANO}
⁴⁾ Haptic technology will also be widely available in the next decade to enable an immersive experience by allowing users to interact physically with their virtual environment. [H](#) These devices use multiple energy forms to create tactile experiences such as ultrasonics, heat, force feedback, water pressure, air pressure, and transcutaneous electrical nerve stimulation. [H](#)

TMAI is exploring the best way to recruit talent, create teams based on their individuals' skills, and tailor individual training needs to increase their performance. Although it is not ready to replace human intervention, TMAI will create teams by recruiting specific candidates, identifying the right talent, and determining whether people or groups are at risk. [H](#) Large technology companies are leveraging TMAI to create tailored teams based on individual member experience, knowledge, and social skills to create diverse, cohesive teams. [H](#) TMAI enables supervisors to conduct employee performance evaluations, remove psychological prejudice, and assist in identifying individual member training needs by focusing on factual-unbiased data. [H](#) TMAI will also stitch together patterns and trends in performance data from multiple sources so leaders can make informed decisions about overall performance. [H](#)

XR will negate the handicap of physical distance, and TMAI will exploit it, thus reduces the traditional burdens distance places on team building. The high skill labor market in the U.S. will become more competitive in the next decade due to a decline in high school

graduation rates, college graduation rates, and natural births. [M](#) At the same time, the U.S. population will continue its significant shift in migration, moving away from dense urban areas in the North and Central U.S. towards small and mid-size metros in the South. [H](#) Advancement, promulgation, and convergence of XR technologies will negate the physical distance barriers of teams and will allow users to connect personally regardless of where they live. The necessity of building teams across a more physically distributed population will allow TMAI to produce more tailored and cohesive organizations because it will have a larger population to pull from.

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ elicitor.org) to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Michael A. Mignano

Advances In Collaboration Tools Highly Likely To Enable Decentralized And Asynchronous Teams Within 5-10 Years

Executive Summary

Advances in collaboration tools are highly likely (71-85%) to enable decentralized mobilization activities within the next 5-10 years. Due to advances in Software as a Service (SaaS) technology, Massive Open Online Course (MOOC) availability, and enhanced smartphones, teams will collaborate synchronously and asynchronously in a decentralized environment on pre-deployment requirements. Despite security concerns and bureaucratic hurdles, fully homomorphic encryption and blockchain technologies will enable collaborative and decentralized mobilizations.

Discussion:

For the past ten years, advances in Software as a Service technology, such as Google, Microsoft Teams, Slack, and Zoom, have enabled teams to produce results in a remote and decentralized manner. [M](#) The COVID-19 pandemic incited a 60 percent increase in remote teamwork applications. [M](#) Near-term collaboration enhancements include intelligent scheduling, interactive whiteboards, and embedded Artificial Intelligence. [M](#) It is highly likely (71-85%) that within the next five years, improvements in virtual reality technologies, including more processing power, improved screens, richer audio, and better ergonomics, will propel VR from a niche capability to the predominant decentralized collaborating tool. [H](#) The 2022 business partnership between Microsoft and Meta will merge 3D VR technology with already established collaboration software and allow teams to work together from decentralized locations even more effectively. [M](#)



Figure 10: Microsoft/Metaverse partnership capabilities and future implications explained.

MOOC technology is an educational resource where participants use personal devices to receive information from renowned educators, inspirational leaders, and practiced trainers on various topics. [H](#) By 2030, it is likely (56-70%) that MOOCs will surpass traditional educational pedagogy due to their scalability, optimization of resources, ability to self-pace, and accessibility. [M](#) The utility of a MOOC education system is that it allows participants to receive remote asynchronous training on the specific curriculum and various

other requirements. [H](#) MOOCs also provide a framework for subject matter experts to provide required information to large populations of personnel. Future MOOCs are highly likely (71-85%) to be more interactive, providing participants with online forums and problem-centric group work. [M](#) [H](#) Coupled with VR/AR technologies, future MOOCs will support group simulations and scenarios. [M](#)

Smartphones will incorporate holographic display technologies rendering 3D images and videos within ten years. [M](#) The next generation of smartphones will include pre-installed digital assistants with more intuitive interactions. [M](#) Additionally, 5G and, by 2035, 6G networks will bring faster download and upload speeds, less latency, and more reliable connections, making team collaboration even more accessible. [M](#) 6G is highly likely to include Mobile Edge Computer (MEC), a network architecture concept that enables cloud computing on mobile networks. [M](#) This will enable cellular users in remote areas to access cloud-based services and data. [L](#)

Using new collaboration tools within teams and organizational training will likely face several security and bureaucratic challenges. Cybersecurity challenges and other web-based threats could expose user data and pose security concerns. [M](#) Despite these challenges, end-to-end encryption and multi-factor identification will continue to evolve. [M](#) Moreover, fully homomorphic encryption will revolutionize how we analyze encrypted data by enabling computations on encrypted data without end users ever having to decrypt it. [M](#) When coupled with blockchain technology, organizations can keep data private while still being able to collaborate and execute powerful data analytics. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and tended to corroborate one another. The analyst worked alone and did not use a structured method. Artificial Intelligence (Perplexity) facilitated topic visualization, problem scoping, and sourcing of reliable information.

Author: LTC Robert (Bob) McTighe

Hybrid Workplace Will Likely Dominate The 2035 Workforce

Executive Summary

The hybrid workplace will likely (56 to 70%) be the dominant corporate work environment in the next ten years. This change is due to the influx of Generation Z (Gen-Z) into the workforce, the increased efficiency and quality of life of hybrid workplaces, and technological advances. Despite the challenge of maintaining cohesiveness over the long term, the workforce proves that a hybrid workplace is effective.

Discussion

A hybrid workplace is a flexible work model that combines working in an office environment, and working gives employees the autonomy to choose where they work, whether it be in the office, from home or a combination of both. [M](#) [M](#) The hybrid workplace model is designed to support a distributed workforce of both in-office and remote workers. [M](#)

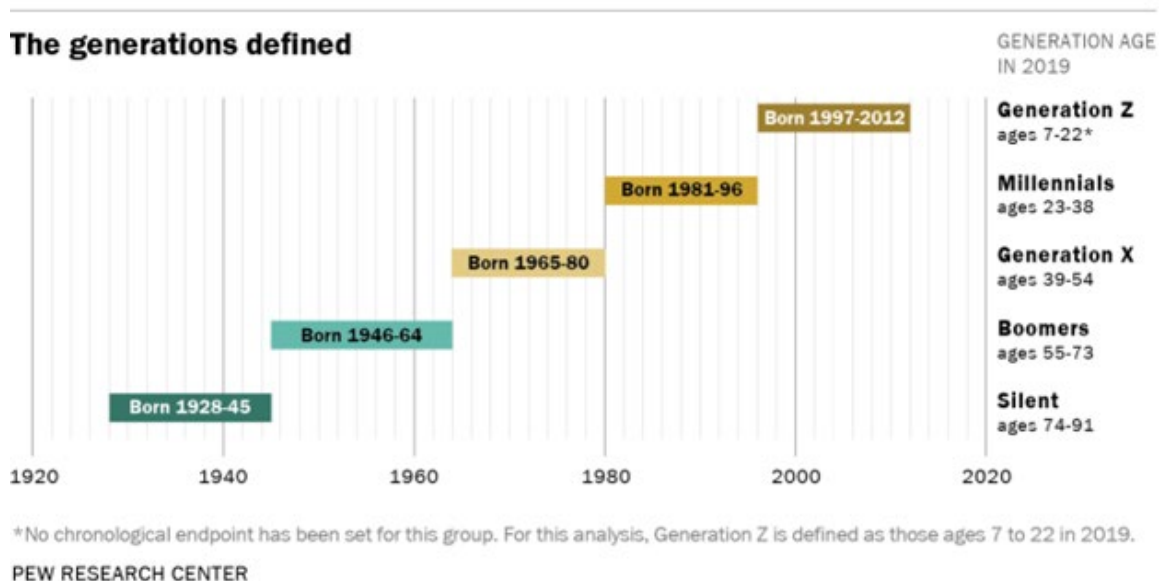


Figure 11: The generations defined

Gen-Z and Millennials currently make up approximately 38 percent of the global workforce, and in 2030 this will increase to about 60 percent. [H](#) In 2030, they will account for 35 percent of the workforce, and they grew up in the digital and information age and view specific platforms and applications as extensions of themselves. [H](#) Millennials and Gen-Z's work habits will require collaboration and cooperation in the 2030 digital workplace. [H](#)

Studies show that Gen-Zs list work flexibility as the number-one employee benefit. ^H In a hybrid workplace, employees typically enjoy more autonomy and better work-life balance, resulting in higher engagement levels. ^M The hybrid higher engagement level yields an increase in productivity. ^M ^M A Stanford study of 16 thousand employees found that productivity increased by 13 percent when staff worked from home. ^M Prodoscore, a leader in employee visibility software, data showed a 47 percent productivity increase in 2020 for remote workers. ^M

Technology, particularly the rapid evolution of people’s communication and interaction, is another factor shaping the 2030 workplace. ^M A recent Stanford Study indicated that employees preferred video calls over in-person meetings for groups with less than four people (figure 2). ^H Technologists forecast a shift from devices people carry to those people wear – a change that will transform the capabilities available to workers. ^M

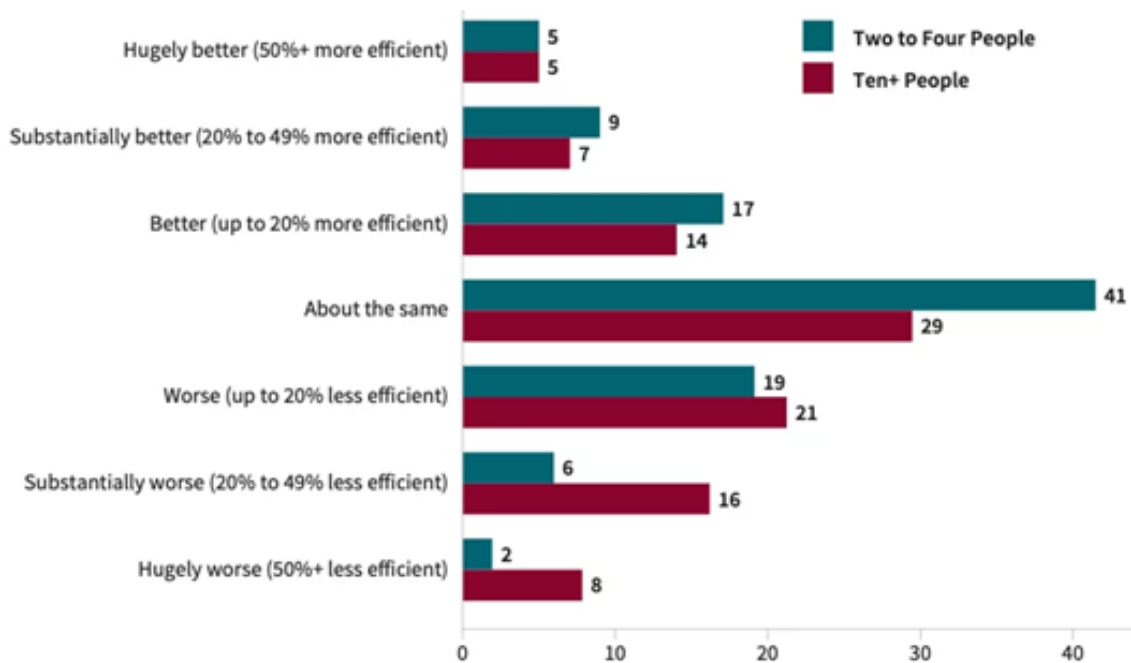


Figure 12: Videocall vs. in-person meetings

The major challenge to the Hybrid Workplace is maintaining cohesiveness over the long term. ^M This is not a new or unique challenge; some solutions make running a distributed team much easier. ^M Future solutions to maintaining cohesiveness in distributed teams include:

1. Wormholes: A continuously open, real-time video connection that acts like an open window between two locations. ^M

2. Online hangouts or happy hours: Video conferencing for social conversations. [M](#)

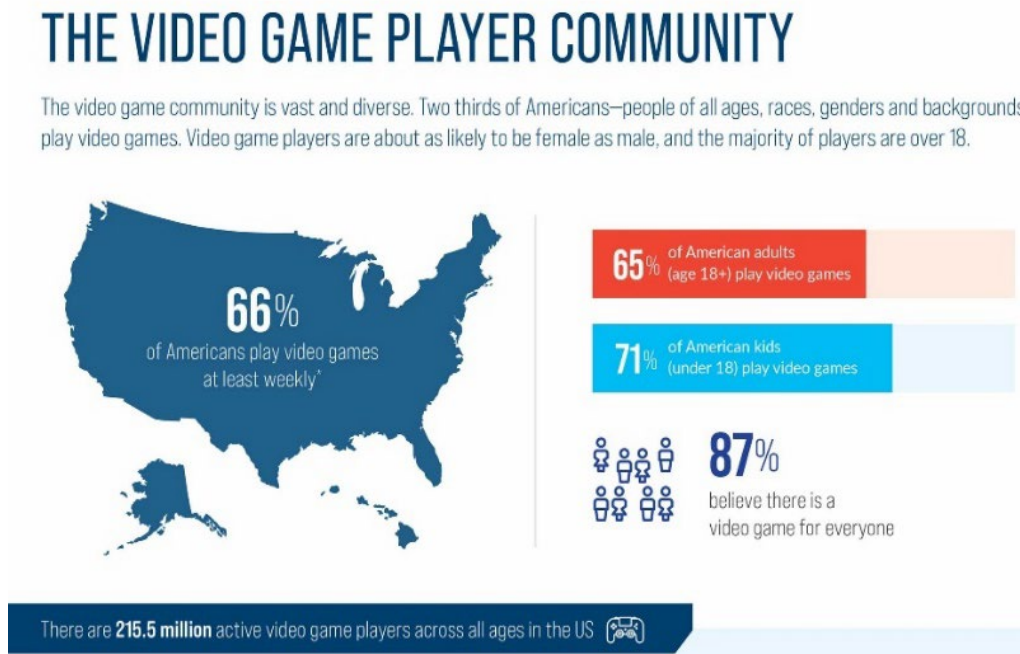


Figure 13: Video Gaming Player Community

3. Coworking allowances: Funds and time for team members to meet. [M](#)
4. Team Video Game Playing: Video games can help build community and strengthen team effectiveness. [M](#) Newly formed teams that played video games together for just 45 minutes were 20 percent more productive. [M](#) [H](#)

Analytic Confidence

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Author: COL John C. Haas, Jr.

Talent Management AI Will Highly Likely Increase Work Performance In Ten Years

Executive Summary

AI-based recruiting and Talent Management Artificial Intelligence (TMAI) systems will highly likely (71-85%) increase work engagement and performance by 50 percent in the next ten years. This change is due to the use of AI in recruiting, team building, and performance management. Despite human resource professionals' lack of AI knowledge and TMAI solutions' promising features and potential gains will continue to grow.

Discussion

TMAI will take over the burden of entering data and sorting through resumes, freeing up to 40 percent of a corporate recruiter's time. [M](#) The program will also automatically create teams by advertising for candidates, identifying the right talent, analyzing social media, and determining whether people or teams are at risk. [M](#)

To create diverse, cohesive teams, IBM is exploring how machine learning can create ideal team members based on their diverse experience, knowledge, and social skills. [H](#) TMAI programs will create successful teams enabling more projects and start-ups to succeed over the next ten years. [H](#)

TMAI will impact performance management practices, including employee engagement, goal setting, and feedback. [H](#) Performance management is a favorite among corporations. [H](#) TMAI performance will concentrate on factual data, employee performance evaluations, removes psychological prejudice, and assists in identifying team member training needs. [H](#) Performance AI will identify patterns and trends in performance data from multiple sources to make informed decisions about team performance. [L](#)



Figure 14: Talent Management Artificial Intelligence (TMAI)

Corporations are showing interest in TMAI, but because most organizations are new to these solutions, a lack of knowledge slows its entry into the market. [H](#) Another aspect affecting adoption among HR professionals is low trust in AI. [H](#) The low confidence is due to the lack of transparency, bias in data, and missing safety/alignment protocols. [H](#) To overcome this barrier, corporations will educate HR professionals on Talent Management AI, improve data quality, and establish safety/alignment protocols. [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ elicitor.org) to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL John C. Haas, Jr.

Significant Recruiting Challenges in U.S Army Reserves Highly Likely Within 15-20 Years

Executive Summary

It is highly likely (71-85%) that the United States Army Reserves will face significant recruiting challenges in the next 15-20 years due to changing demographics, a decline in the recruitment pool, and competition for critical skills, despite an increase in population or external economic conditions. The population of natural born citizens entering the workforce will likely peak in the next five years, at the same time, immigrants, who are not currently as inclined to volunteer for military service, will fill in the gap. Simultaneously, the Army Reserves will have to compete with industry for a smaller and more diverse demographic of skilled labor entering the workforce in the next 15-20 years.

Discussion

Immigration will expand the working age population of the U.S. in the next 10-15 years. The U.S. fertility rate in 2020 was 1,641 births per thousand women, 22 percent below a natural replacement birthrate. [H](#) By 2034, older adults will outnumber children for the first time. [H](#) According to the United States Census Bureau, in 2030 immigration will overtake the natural increase as the primary driver of population growth. [H](#) The

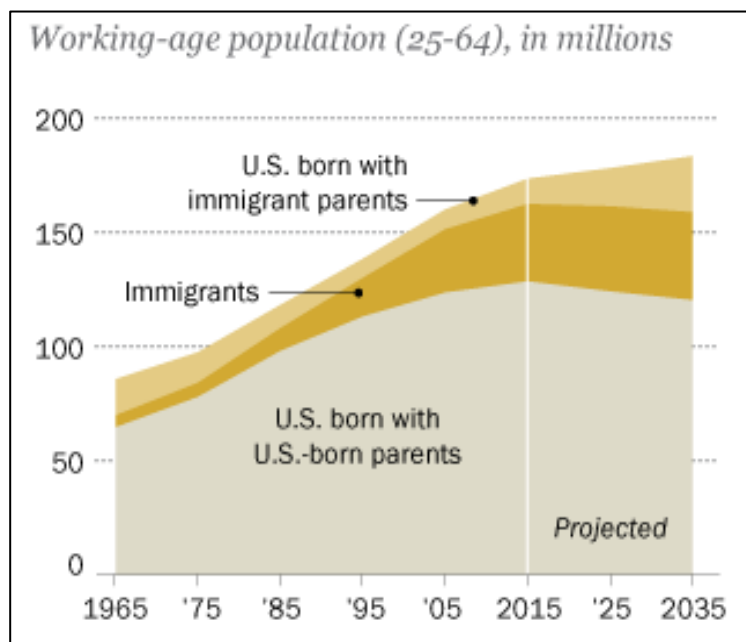


Figure 15: Working Age Population

Pew Research Center estimates that the number of working-aged adults will rise from 173 million in 2015 to 183 million in 2035. [H](#) The working-aged population born from native-born citizens will shrink by 8 million, but will offset by an increase of 13 million first-generation citizens, and 18 million immigrants (See Figure 1). [H](#) This change in demographics will shrink the pool of candidates inclined towards military service. The current U.S. population is approximately 14 percent foreign born but comprise less than four percent of the armed forces. [M](#)

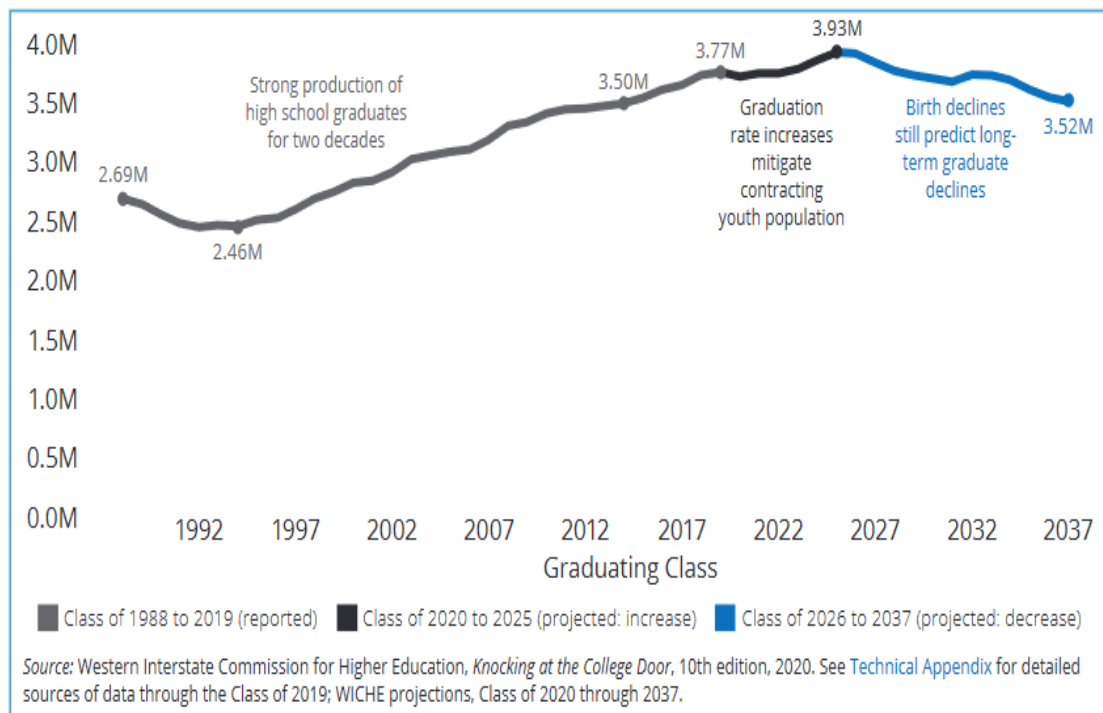


Figure 16: High School Graduates

The reduction in high school and college graduation rates will shrink the pool of potential enlisted recruits even further. The number of high school graduates is projected to peak at approximately four million in 2025, and then decline at least through 2037. [M](#) Undergraduate college enrollment peaked in 2010, at 18M, and steadily declined to 15.85 million in 2020. [M](#) Future college enrollment projections are unreliable due to COVID, but trending downward. [M](#)

Private industry will force the Army Reserves, comprised of many technical occupational specialties, to compete for a shrinking pool of highly skilled candidates with a better-paying private industry. A 2022 National Science Board's "The State of U.S. Science and Engineering 2022" report concluded that United States primary school students' scores are not improving in science, technology, engineering, and math (STEM) [H](#) The same report found that the unemployment rate of the STEM workforce was two percent compared to the non-STEM unemployment rate of four percent in 2019 and held steady through the COVID-19 pandemic. [H](#) STEM jobs are highly competitive with a median salary of USD 95 thousand in 2021 (double the national average) and these occupations will grow at over twice the rate of non-STEM jobs for the next ten years. [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Michael A. Mignano

Americans Will Mass in Southern Suburban Metro Areas Regardless of Increased Risk of Natural Disasters

Executive Summary

Americans are likely (49-65%) to migrate out of rural and dense urban areas in the Central and Northern U.S. due to economic advantages and an aging native population in suburban metro areas in the Southern U.S. Foreign-born citizens will drive population growth after 2030, but their migration patterns yield an uneven distribution, about half live in urban areas. The surplus of large-family homes left by seniors primarily residing in suburban metros will exacerbate migration to those areas. Despite warnings of an impending climate migration from high to low-risk areas, state, and federal government-subsidized insurance programs in the Southern and Coastal U.S. will incentivize residents from relocating.

Discussion

Domestic migration accelerated from larger urban and rural areas to mid-sized and smaller metros primarily for economic reasons. [H](#) Dense urban areas have a higher housing cost and less living space available than suburban metros, and rural communities have significantly lower wages. [M](#) The larger a suburban community, and the closer it is to a large urban area, the higher the wages. [H](#) Data from National Van Lines showed that between 2020 and 2022, the South's population increased by 2.5 million people and was the largest of any region, while populations in the Northeast and Midwest declined. [M](#) Allied data showed that fewer people moved in 2022 compared to 2021 but concluded that those who did relocated to the South because of stronger economic opportunities and a lower cost of living than the West Coast or Northeast. [M](#)

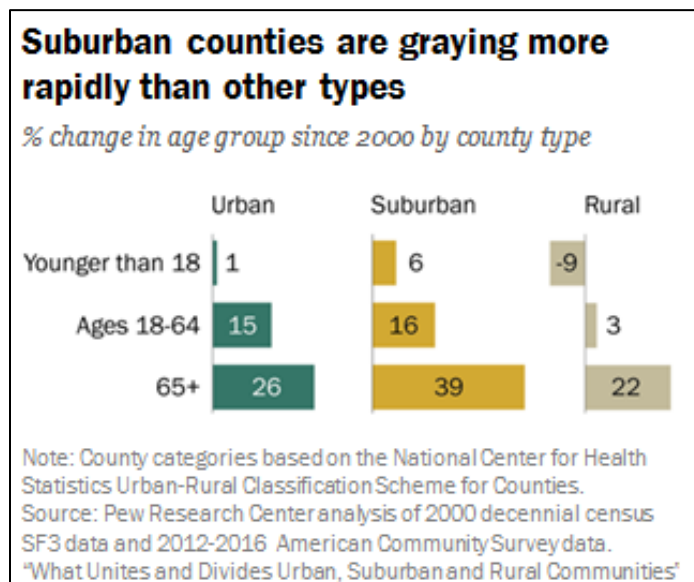


Figure 17: Change in County Type Demographics

According to the United States Census Bureau, in 2030, immigration will overtake the natural increase as the primary driver of population growth. [H](#) About half of the foreign-born population lives in urban areas, and do not distribute evenly across county types. [H](#) In 2018, foreign-born residents made up 22 percent of urban, 11 percent of suburban, and four percent of the rural counties in the U.S. [H](#) As the aging native population begins to recede

rapidly, they will make up an even larger portion of the urban population.

The surplus of large-family homes left by seniors will exacerbate migration to suburban areas. By 2034, older adults will outnumber children for the first time. ^H As of 2016, 58 percent of seniors lived in the suburbs within metro areas. ^H From 2000 to 2018, the 65-and-older population grew 39 percent in the suburban areas (see Figure 1). ^H A significant surplus of large single-family homes, caused by seniors expiring or downsizing, will lead to lower home prices in suburban areas. ^M This large source of cheap housing will attract younger buyers and families priced out of the market previously. The deaths of seniors will naturally increase the percentage of the population that reside in more populated areas.

Despite projections of climate migration from high to low-risk natural disaster-prone areas, state and federal government-subsidized insurance programs will incentivize residents from relocating. The U.S. population is moving into areas with higher risks of climate impacts causing natural disasters to be more expensive. ^H Many insurers no longer cover properties with high natural disaster risk, but all states offer Fair Access to Insurance Requirements (FAIR) or similar plans to cover commercially uninsurable property. ^H State taxes subsidize FAIR, and several private insurance companies share the risk of a single property. ^H The federal government also provides flood insurance through the National Flood Insurance Program to otherwise uninsurable commercial and private real estate located in high-risk flood areas. ^H To lower the long-term costs of natural disasters, some states are offering incentives such as discounts on insurance or tax credits to homeowners who make their homes more resistant to fires, wind, rain, and hail. ^H

Analytic Confidence

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Author: LTC Michael A. Mignano

Advances in Technology Will Highly Likely Prepare Commercial Enterprises to Compete in a Business Environment of the Future

Executive Summary

Advancements in technology will highly likely (71-85%) equip commercial enterprises with the necessary tools to thrive in the fast-paced business environment of the future. Businesses investing in simulations, Virtual Reality (VR), Augmented Reality (AR), cognitive technologies, and mobile applications are likely to adapt quickly to changing conditions and remain competitive. Despite companies not investing in VR, AR, and mobile applications, it is possible to stay competitive, it is unlikely to be successful in the future, as businesses must quickly adapt to changing conditions to maintain their competitiveness.

Discussion

Simulation training, in method and technology-aided, provides a point-of-care learning experience in fields such as aviation, the military, and healthcare in a controlled environment. [M](#) The simulation training market is poised to grow by USD five trillion by 2027, accelerating at a compound annual growth rate of seven percent. [M](#) Hewlett Packard (HP) uses the training simulation made with an optical hand-tracking module to provide an engaging learning environment for its workers' hardware repair training. Employees work in realistic environments where they can disassemble the server to address broken components utilizing a virtual trainer and branching situations resulting in staff members being better prepared for actual workplace scenarios. [M](#) The Occupational Health and Safety Administration (OSHA) found that harnessing the power of computer-based simulation of work experience increases the learner's involvement and interest in the material. [M](#)

Business organizations will likely adopt VR and AR technologies as training methods in preparing for hasty, large operations such as disaster recovery, corporate mergers, or industrial projects. Individuals trained with VR were more confident to act on what they learned after training — a 40 percent improvement over a classroom and a 35 percent improvement over e-learn training. [M](#) These developments give employees more realistic experiences that can increase training efficiency. This immersive experience can lead to better memory retention, according to the results of a 2018 study published in the journal Virtual Reality. [M](#) VR training also allows organizations to identify areas where there may be more incidents and provide focused skill refreshers that reinforce proper procedures and give feedback without additional consequences or safety risks. [M](#)

In addition to a significantly quicker pace of learning, VR training promotes more significant focus, giving employees better knowledge retention and improved

understanding. ^M General Motors (GM) created a robust Adobe Connect platform, utilizing the features of Virtual Classroom and On Demand to facilitate quick training and mobile learning. ^M This allowed 300 thousand GM employees from a wide range of positions rapid job-specific training in a short duration.

Commercial organizations will likely use cognitive technologies designed to simulate human thought processes and perform tasks that typically require human intelligence, such as perception, reasoning, and learning to enable quicker operations. Cognitive technologies extend the power of information technology to tasks traditionally performed by humans, and they have the potential to allow organizations to break

prevailing tradeoffs between speed, cost, and quality. ^M To identify future supplier issues and predict worldwide trends up to three months in advance, DHL employs AI and ML to evaluate more than eight million internet posts daily using approximately 240 million variables. ^M In the third stage of AI utilization, companies will reach autonomous intelligence, where machines, bots, and systems can directly act on the intelligence they derive, substantially automating and digitalizing processes. ^H Asset Intelligence solutions can autonomously modify dynamic pricing on retail shelves, recalculate warehouse staffing predictions, calibrate industrial equipment, and improve supply chains. ^H

Commercial businesses will likely use online learning environments and mobile apps to assist with their quick and extensive operations. Online courses will get a big boost from AR, VR, and AI advances. ^H The Research Institute of America discovered that online learning increased retention rates by 25–60 percent. ^M Learning Management Systems (LMS) will provide a comprehensive toolkit of analytics and reporting tools that organizations can use to visualize and retrieve valuable data. ^M LMS can replace or enhance dated methods of monitoring trainee performance. ^L It provides robust reporting and significant insights into individual and group performance. An LMS can improve collaboration by allowing an organization to centralize training materials and information,

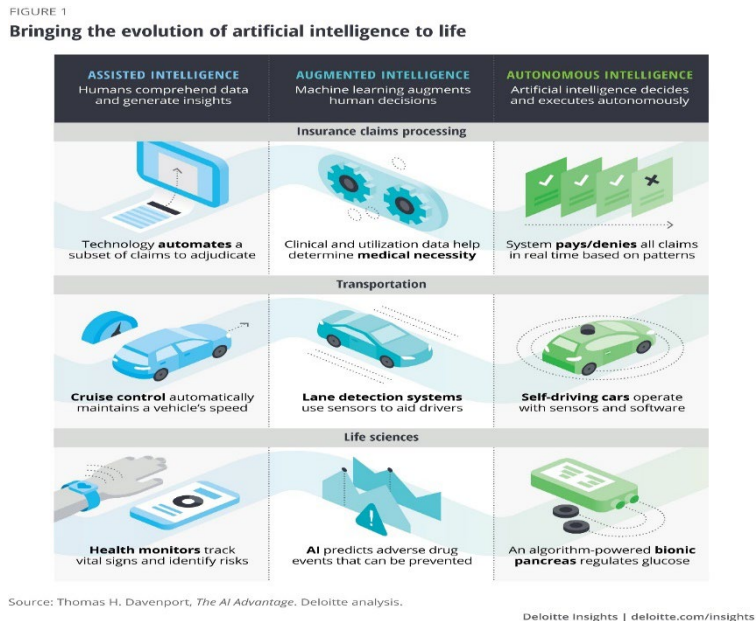


Figure 18: Bringing AI to Life

streamline project management, and integrate with other tools. [M](#)

Analytic Confidence

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Author: COL Robert J. Shadowens

Advances in Virtual Reality Will Highly Likely Revolutionize How Dispersed Teams Collaborate in the Next Ten Years

Executive Summary

Virtual reality (VR) technology will highly likely (71-85%) revolutionize how dispersed teams collaborate over the next ten years. Extended Reality (XR), holograms, and brain-computer interfaces (BCI) will change VR capabilities and improve team proficiency and productivity. Despite a high implementation cost, lack of experience, usage, and confidence in VR technology today, the availability and use of VR will increase, driving down costs and establishing an ever-increasing impact on team development.

Discussion

As technology advances, the future of simulations in VR and AR is likely to become increasingly immersive and engaging, providing users with experiences that involve all their senses, including touch and smell. [L](#) Although current technological limitations may prevent full dive VR, developing more realistic visuals, improved eye and motion tracking, and increasingly sophisticated headsets suggest that XR (extended reality) will become a significant part of our lives. [L](#) Advancements in XR provides immersive learning experiences that allow individuals to travel the world, explore complex concepts, and experience learning directly from a safe and secure environment. [M](#) This experiential learning improves personal understanding, attainment, and knowledge retention. [M](#) Advance simulations help team building by allowing employees to experience different scenarios to help them prepare for the real thing. [M](#) These technologies can also improve collaboration, eliminate bottlenecks, and enable lean delivery, leading to improved project delivery. [M](#) VR learners are more confident in applying what they've learned, with up to a 275 percent increase in confidence compared to classroom learners. [M](#)

Projecting holograms in a natural position and shape can enhance the real world with computer-generated information. [M](#) Teams can see and interact with images of projects they are working on collectively using VR and AR technology. [M](#) Virtual communication technologies, using 3D holographic pictures, promise to unify a workforce that has grown increasingly distant. [M](#) One method is tensor holography, which uses learning to accelerate computer-generated holography, allowing for real-time.

hologram generation. [M](#) Tensor holography will create realistically holographic images in virtual reality training. Tensor Holography synthesizes a 3D hologram with per-pixel depth from a single Red Blue Green-Depth (RGB-D) image in real-time. [H](#) Powered by deep learning, this technology will make real-time holography feasible on laptops and smartphones. [M](#) Tensor holography technology creates realistic 3D holographic images for virtual and augmented reality headsets. [M](#) This technology could enhance virtual reality systems by immersing users in a more realistic environment. [M](#) There are challenges today that come from the need to compute realistic holographic patterns from 3D data, transmit data to display technologies, and meet strict system requirements for low-latency transmission across vast distances. [M](#)



Figure 19: Hologram Technology in the Future

BCI technology allows for direct communication between the brain and an external device and, when combined with VR tech, has the potential for training dispersed teams; however, integration requires a framework that can acquire and process data from different sources. Various organizations, including the military, actively research and fund BCI technologies. [H](#) Experts believe this technology could become more widely available in the next few years, while others suggest it may take longer to mature. [H](#) [H](#) Collaborative virtual environments in which multiple users communicate and exchange mental information via an interface create new ways of interacting with one another. [M](#)

A framework capable of acquiring data from different sources, processing data, and performing subsequent analysis based on user experience should manage the integration and synchronization of VR devices and BCIs. [M](#) Scientists explored multiplayer and collaborative games to improve the effectiveness and engagement of BCI users. [M](#) A combination with AR technologies allows users to interact with a mix of real and virtual objects, contextual elements, and each other while using the headset integrated with a BCI headband. [H](#) Compared to conventional training paradigms, computer interfaces in VR offer a far more immersive experience when teaching dispersed teams. [M](#) Several studies have shown that electroencephalography (EEG) effectively controls drones in virtual and augmented reality environments. [H](#) Guidelines for the mental tasks-BCI training environment recommend taking advantage of social presence to improve user experience,

effectiveness, and engagement of BCI users. [M](#) BCIs in VR have great potential for training dispersed teams by providing an immersive experience that allows team members to interact with each other through avatars.

In the next five years, analysts project that the AR/VR market will experience exponential growth, exceeding USD 15 billion in 2022 and growing by an additional 77 percent in 2023. [M](#) As the market for extended reality capabilities grows experts expect that smartphones and other electronic devices will evolve to incorporate AR/VR technology. [M](#) Advances in smartphone technology, such as better cameras and processors, will mean that AR/VR experiences will become more affordable, mainstream, and effective over time. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable, numerous, and corroborative. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst used artificial intelligence to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to innovation in capabilities and information.

Author: COL Robert J. Shadowens

Synthetic Training

Synthetic Training Replicates Combat Environment And Is Likely To Replace In-Person Training By 2035

Executive Summary

The Synthetic Training Environment is highly likely (71-85%) to replace in-person individual and collective training as the preferred deployment preparation method by 2035 due to advances in Extended Reality (XR) capabilities, collaborative Artificial Intelligence (AI) tools, Massive Open Online Course (MOOC) content, and novel certification tools. Despite the high initial investment costs and cultural turbulence regarding the validity of synthetic training, cost savings, system efficiencies, decentralization, and overall effectiveness will drive the full acceptance of this alternate approach.

Discussion:

With XR innovation efforts led by Program Executive Office Simulation, Training, and Instrumentation (PEO STRI), the Army is testing and plans to begin fielding its three key components (Integrated Visual Augmentation System [IVAS], Reconfigurable Virtual Collective Trainer [RVCT], and One World Terrain [OWT]) throughout the year and into the foreseeable future. [M](#)



Figure 20: Synthetic Training Environment Information

The IVAS integrates squad equipment in scenarios with an Artificial Intelligence (AI) enabled enemy, all within a virtual environment. [M](#) The IVAS dual nature provides a virtual training tool and a real-life target acquisition, marking, and navigation tool. [M](#) The RVCT uses interactive equipment, including a heads-up display, high-resolution monitor, and representational controllers, to enable collective training in a Mixed Reality (MR) setting. [M](#) Feeding both previous XR tools, OWT provides three-dimensional terrain replicating the operational environment's complexities. [M](#)

Through continued investment and operational necessity, XR technology is highly likely to evolve to a replication level so natural that it proves more valuable than in-person training. The haptic feedback technology market, which uses tactile sensations to give users a sense of touch and feel in response to digital stimuli, is expected to experience a 12 percent compound annual growth rate. [M](#) [M](#) [H](#) As this technology grows, it will better simulate natural environments providing realistic and immersive sensations that support individual and collective training. [M](#) [M](#) Advanced haptics will likely (56-70%) achieve functions like maintenance and individual soldier tasks in virtual environments as future iterations come to fruition. [H](#)

By 2035, it is highly likely that soldiers will have the ability to complete specific individual tasks from their homes. Although the military has mainly focused its XR innovation on collective training, individual training is a likely future application of XR technology. [H](#) Additionally, for the past ten years, advances in Software as a Service technology (SaaS) enabled teams to produce results in a remote and decentralized manner. [M](#) The COVID-19 pandemic spurred a 60 percent increase in remote teamwork applications. [M](#) [H](#) It is highly likely that within the next five years, improvements in XR technologies and collaboration tools will allow the military to organize and execute asynchronous mobilization training while tracking pre-deployment requirement status. [H](#) Furthermore, XR training systems will likely embed incentives and rewards in a gamified manner, encouraging participation while promoting more outward interactions, ultimately enhancing teams from afar. [H](#) [M](#) [H](#)

MOOC technology is an educational resource where participants use personal devices to receive information from renowned educators, inspirational leaders, and practiced trainers on various topics. [H](#) This increasingly popular education tool will see a projected 35 percent annual growth in the next five years. By 2030, MOOCs will likely surpass traditional educational pedagogy due to their scalability, optimization of resources, ability to self-pace, and accessibility. [M](#) [M](#) The military utility of a MOOC education system is that it allows soldiers and leaders to receive remote asynchronous training on specific pre-deployment curriculum, theater socio-economic factors, geography, enemy capabilities, and various other requirements. [H](#) They also provide a framework for military subject matter experts to provide required information to large populations of deploying personnel. Future MOOCs are highly likely to be more interactive, providing participants with online forums and problem-centric group work. [M](#) [H](#) Coupled with XR technologies, future MOOCs is likely to support group simulations pertinent to combat scenarios. [M](#) [H](#)

Currently, the United States Army Reserve and First Army facilitate, physically observe, record, certify, and validate all pre-deployment training. [H](#) In the future, AI and digital collaboration tools will enable tracking of training requirements through completion. In a recent simulated exercise at Fort Hood, TX, which used the RCVT as the primary XR training tool, Observer, Controller, and Trainers executed their duties using the same virtual tools as the training audience. [M](#) Moreover, they used those same tools to enhance the after-action review process. It is highly likely that virtual trainers will facilitate future training that uses AI to determine training deficiencies in both collective and individual training tasks, then coach participants to an acceptable standard. [M](#) [M](#) The combination of AI-enabled feedback, enhanced collaborative tracking tools, and virtual coaches will make future training certification more streamlined and decentralized.

The two most significant obstacles to a synthetic training environment replicating in-person training are the high costs of emerging technology and the cultural resistance of two alternate training approaches. In the next five years, analysts project that the XR market will experience exponential growth, exceeding USD 15 billion in 2022 and growing by an additional 77 percent in 2023. [M](#) Maintaining pace with the commercial market and implementing the best XR military solutions is resource intensive. Nonetheless, the potential for training efficiencies, decentralization, and long-term cost saving is significant and will ultimately override the high implementation costs. [M](#) The larger hurdle is resistance to cultural change. Executing virtual individual and collective training is a substantial shift in the norm. According to a project manager at PEO-STRI, most leaders she has encountered have accepted virtual training as a building block to get to live training but not as a complete replacement. However, familiarity with these systems builds acceptance. [H](#) It is likely that cultural change will occur as XR systems continue to advance.

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and tended to corroborate one another. The analyst worked alone but used many Short Form Analytic Reports from colleagues that confirmed the findings. Artificial Intelligence (Perplexity, ChatGPT) facilitated topic visualization, problem scoping, and sourcing of reliable information.

Author: LTC Robert (Bob) McTighe

Gaming is Likely To Become the Primary Media For Learning Within The Next 5-10 Years

Executive Summary

Gaming is likely (56-70%) to become the primary media for learning and involve more personalized experiences within the next 5-10 years due to trends in consumer demand, advanced technology, and changing workforce demographics. Despite the increasing costs of the technology and its perceived education limitations, new monetization models and a surplus of investors will continue to create revenue and advance the industry.

Discussion

Gamifying something is the process of adding elements to a task to encourage participation and involve outward interaction. ^H This process makes experiential learning activities more enjoyable by providing rewards to enhance participation and productivity. ^M It motivates participation by applying mechanics and aesthetics to promote learning. ^M Design methods like Peloton leaderboards and Duolingo achievement status encourage learning through badges, points, contests, streaks, and other incentives. ^M Additionally, Extended Reality (XR) systems and the Metaverse enhance the gaming experience by further immersing players in the game. ^M According to Dr. David Chandross, Professor and the lead designer at Game and Train, experiences in the virtual world will radically improve skill acquisition, motivation, engagement, and learner achievement tracking. ^H



Figure 21: How to build a Gamification Strategy

By 2030, gamification will likely (56-70%) involve more personalized and social experiences. Researcher and CEO of PentaQuest, Kerstin Oberprieler, believes that engagement mechanics will drift more towards collective purpose than individual achievements, especially in the non-profit sector. ^M Interactive experiences will likely increase rapidly in the health, education, business, and military sectors in the coming years. Systems will move beyond learning and towards the gamification of behaviors. In education, health, and business, concepts that promote positive behaviors by providing

external rewards and increasing rewards in non-game contexts will become the norm. ^L Game-like elements affect different demographics in various ways. Younger generations,

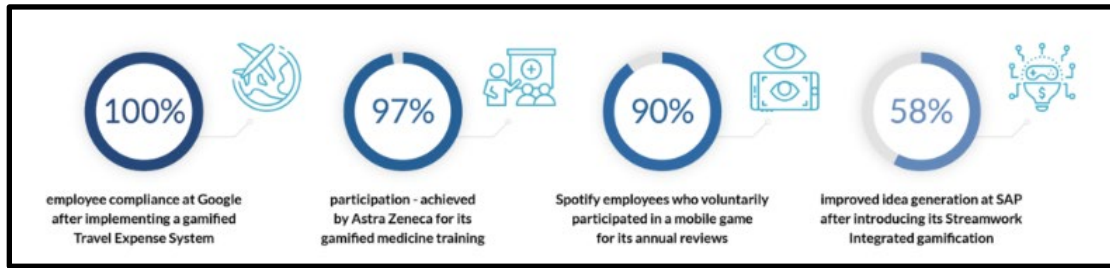


Figure 22: Figure 2: How Gamification is changing outcomes in Organizations

such as Generation Z, who grew up online, tend to respond well to these concepts. They expect real-time data, instant feedback, and value recognition and rewards for their efforts. ^M Although age plays a role in the accessing and appeal of interactive competitive learning, the benefits of these concepts appear equal across different age groups. ^H By 2030, with 58 percent of the global workforce composed of Millennials (age 34-49) and Generation Z (age 18-33), the appeal for gamified systems is almost certainly greater. ^M

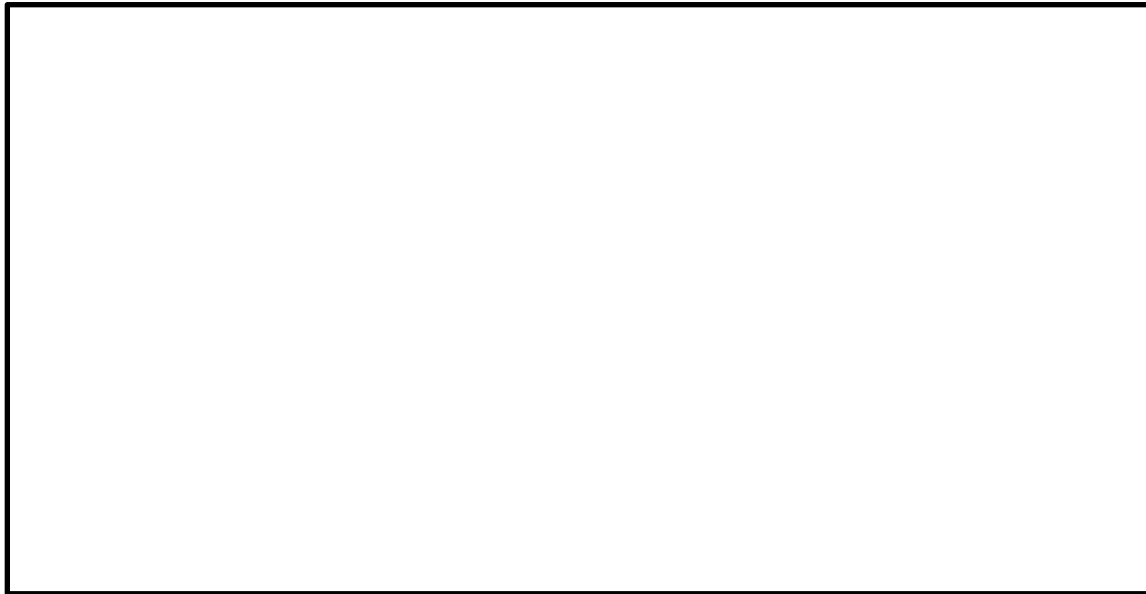


Figure 23: Weekly hours spent on games over different media types

The military uses gamification to support training, leader development, and learning. ^M As examples, these processes have enhanced the memorization of procedures, marksmanship, and decision-making. ^M In the future, individuals and teams can experience professional military education as playful quests with clear goals that they must achieve to advance. Simulations with a mechanism for achievement are also ways to test trainees on procedures before entrusting them with expensive equipment and lives.

Extensive virtual-world interactive simulations range from USD 80-300 Million to produce, and based on historical trajectory, production will likely increase to around USD 1 Billion for the most complex games. ^M Despite these growingly high overhead operating costs, new monetization models will continue to advance interactive digital revenue writ large. Opportunities for microtransactions and advertisements coupled with an influx of USD 240 Billion in venture capital, private equity, and acquisition investments over the past four years will eventually offset the operating costs and facilitate the continued industry growth. ^M A second concern in the future of this industry is the continued utility in education. A 2018 study titled “The Dark Side of Gamification” identified indifference, loss of performance, undesired behavior, and declining effects as adverse outcomes. ^H However, rigorous research continues to evolve this industry into a more substantial science with theories and frameworks that can apply across a broad range of applications. ^H In the future, strategically focused gaming will go further than incentivizing. Instead, it will empower meaningful interactions that build human agency, autonomy, and capability. ^H

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and tended to corroborate one another. Verified AI platforms (Perplexity, Unrestricted Intelligence) assisted the author with project visualization, scoping, and sourcing.

Author: LTC Robert (Bob) McTighe

FEMA Will Highly Likely Be A Proactively Data-Driven Organization By 2035

Executive Summary

Federal Emergency Management Agency (FEMA) disaster planning and emergency response will highly likely (71-85%) be a proactively data-driven organization by 2035. The change from historically reactive-based decision-making is due to advances in artificial intelligence and machine learning (AI/ML), blockchain databases, and Virtual Reality (VR). Despite the corporate culture's resistance to becoming data-driven, FEMA will be a proactive data-driven organization.

Discussion

FEMA has a history of using human intuition and reactive decision-making to coordinate large federal personnel and resources deployments in response to national disasters. [H](#) For example, FEMA's Hurricane Harvey response efforts included evacuating 24 hospitals, restoring drinking water capability to 61 communities, closing 23 ports, and making 781 roads passable. [H](#) More than 21,000 federal staff deployed in support of Tropical Storm Harvey. [H](#)

Government emergency response agencies now use AI/ML applications to change how we respond during a disaster. [H](#) These applications track events in real-time and respond in a way that is more efficient than human and reactive decision-making techniques. [M](#) Pacific Northwest National Laboratory RADR is a disaster response and situational awareness tool that combines imagery collected by satellite, airborne, drone, and social media platforms and applies AI-based image analysis algorithms to detect hazards, damage, and risks to community lifelines. [M](#) During the 2015 Nepal earthquake, AI reviewed tweets and images to identify urgent needs and infrastructure damage, mobilizing resources as needed. [H](#) [M](#) The Cincinnati Fire Department uses a new predictive analytics system to surface recommendations to dispatchers on appropriate responses to emergency calls based on several variables, including location, weather, and inputs from similar types of calls. [M](#)



Figure 24: Pacific Northwest National Laboratory RADR

The FEMA's Public Assistance program is researching the implementation of blockchain for tracking resources during and after a disaster. [M](#) Seeing the potential of blockchain, the Department of Homeland Security's (DHS) Science and Technology Directorate awarded Over USD 1 million in grants to explore the technology through their Small Business Innovation Research program. [M](#) The Center for Disease Control (CDC) is looking to pilot a blockchain for public health data surveillance. It will collect and communicate data to entities that treat patients in disaster relief scenarios, including local public health agencies, hospitals, and pharmacies. [M](#)

First responders could use the data collected by blockchain to provide additional information to during rescue missions, and train individuals for emergencies. [H](#) Over the past decade, virtual reality-based disaster preparedness training is an important alternative to traditional real-life drills and tabletop exercises. [H](#) Several DHS projects in development aim to align with modeling and simulation priorities at the FEMA National Exercise Simulation Center to create tools that may support future national-level exercises. [M](#) This technology can prepare for disasters in several ways: tactical, strategic, or narrative training sessions. [H](#) Immersed" is the first large-scale virtual reality tool developed by FEMA to educate local officials on flood risks by fully immersing users into the center of a flood crisis, allowing them to assess damage in a community. [H](#)

The challenge for a business to adopt a data-driven approach stems from something other than technology or data obstacles, but from cultural resistance within the corporation. [M](#) several leading organizations are constructing internal swat teams combining business leaders, data scientists, and data engineers/architects to drive culture change toward the data-driven approach. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ elicit.org) to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL John C. Haas, Jr.

Widespread AR/VR Familiarity Highly Likely Within Ten Years

Executive Summary

Virtual Reality and Artificial Reality (AR/VR) familiarity is highly likely (71-85%) to be widespread in U.S. society within ten years due to growth in commercial retail, education applications, and gaming. Like the personal desktop computer, the classroom will drive for exposure to AR/VR. Technology in the commercial retail space is widening consumer familiarity in everyday experiences. Despite the high price and lack of VR content, the AR/VR commercial gaming market, has a 31 percent annual growth rate.

Discussion

Similar to widespread implementation of the personal computer, the classroom will drive for AR/VR technology implementation. In 2018, the market research valued the market for virtual reality in education at USD 656 million, and is predicted to grow to USD 33 billion by 2026 (see figure 1). ^H Commercial retailers, such as

RobotLAB, offer ready to use stand-alone VR kits specifically geared for classrooms which include headsets, controllers, and teacher training. ^H At all 28 schools within Illinois School District 54, students undertook virtual field trips to the moon, WWI battlefields, and Ellis Island with VR headsets. ^M As an example of the collaborative power of VR, the Hussman School of Journalism and Media created a virtual replica of their lab that enables students to move around the room, form groups and interact with one another at various tables or meeting areas, and write on virtual whiteboards. ^H Major corporations such as Google, Microsoft, Facebook Technologies, IBM Corporation, and Samsung all entered the AR/VR market.

The use of AR/VR in the commercial retail space widens consumer familiarity to the technology. AR purchasing increases the perceived value of both the company and its products, which in turn increases product sales. ^H The market research anticipates that the size of the worldwide AR in the retail market will increase from USD 1.5 billion in 2020 to USD 4.6 billion by 2026 at a compounded growth rate of 20 percent. In partnership with

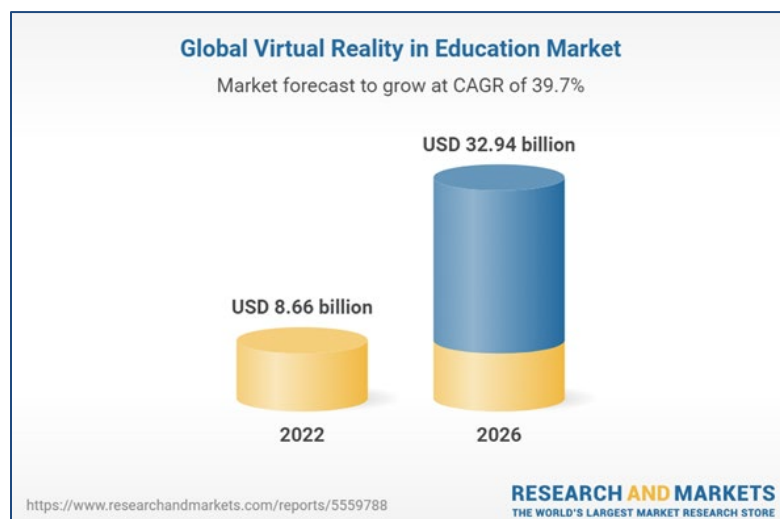


Figure 25: VR in Education Market Size

Facebook, L'Oreal now provides augmented reality-enabled makeup try -on experiences. Leading cosmetics companies, including Maybelline, L'Oréal Paris, Lancôme, Giorgio Armani, Yves Saint Laurent, and Urban Decay are available for customers to try out. ^H IKEA created The Place App, which enables users to place furniture products into their homes using augmented reality and their smartphone camera to see how the item would appear there. ^H Volvo employed VR to allow consumers to experience a test drive of the XC90 and a digital showroom where they explore and purchase the vehicle. ^H Japan's All Nippon Airlines give viewers a VR tour of its new business class cabin, allowing them to use all the cabin's features without boarding the aircraft. ^H

Despite the high price and lack of VR content, the AR/VR commercial gaming market, has a 31 percent annual growth rate. ^{M M} The VR gaming market is trending to reach USD 53 billion by 2028, and the AR gaming market 43 billion dollars the same year. ^{M M} Before 2020, experts cited the two most commonly cited barriers to VR adoption as the price of headsets and lack of content. ^M However, due to the widespread implementation of lockdowns during the COVID-19 outbreak, the market for VR gaming saw a substantial uptick in consumer acceptance. ^M The number of people playing AR and VR games will reach 216 million by 2025. ^M Large companies such as Apple, Sony, and Meta are entering the market with AR and VR headsets and investing heavily in gaming and everyday application content. This competition will continue to drive down costs and innovate new content.



Figure 26: Apple Glasses Concept Art

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Michael A. Mignano

Highly Likely that Crowdsourcing and Crowdfunding Will Enable Advanced Haptics Accessibility Over the Next Decade

Executive Summary

It is highly likely (71-85%) that advanced haptic technology will be widely available within ten years due to adoption by commercial product manufacturers, and rapid advancement in the technology. Commercial retailers are exploring ways to incorporate Ultrasonic haptic devices into commercial retail products such as automobiles, home goods, and laptops. The extended reality (XR) industry is rapidly evolving advanced haptic technology to create a more immersive and interactive experience by allowing users to interact with their XR environment physically. Advanced haptic devices currently cost users thousands of dollars, but crowdsourcing and crowdfunding will democratize the technology.

Discussion

Commercial retailers are exploring ways to incorporate Ultrasonic haptic devices into commercial retail products such as automobiles, home goods, and laptops. Ultrasonic haptic devices create tactile feedback by using ultrasonic waves to generate vibrations in the air. These vibrations direct toward specific areas of the



Figure 27: Emerge Wave-1 Concept Image

user's body to create a sense of touch without the burden of using a wearable device. [M](#) A California startup company, Emerge, successfully developed an ultrasonic haptic device that interfaces with Meta's Quest 2 VR system in mid-2022. [H](#) Ultrahaptics and HARMAN teamed to demonstrate the feasibility of ultrasonic haptics in-vehicle infotainment and audio systems as early as 2017. [H](#) Ultrahaptics' predecessor, Ultraleap, signed a development agreement with Hosiden in 2021 to commercially incorporate ultrasonic haptics into future vehicles. [H](#) French company Hap2u seeks to integrate ultrasonic haptics into smart home appliances, vehicles, and laptops. [H](#) These recent innovation trends demonstrate the desire to merge haptics into everyday technology.

The XR industry is rapidly evolving advanced haptic technology to create a more immersive and interactive experience by allowing users to interact with their XR environment physically. Haptic gloves are wearable devices that provide haptic feedback

by vibrations, heat, pressure, or electricity to create realistic sensations of touch and texture with a wireless capability. HAPTIX's commercially available glove system utilizes 135 air-powered actuators on each hand, which requires a cumbersome backpack with an 18-month usable life. ^M Driver-X is developing dual-purpose VR



Figure 28: WeTac Prototype

controller and a haptic glove that utilizes electronically stimulated alloys to simulate tactile feedback on a user's fingertips. ^M In late 2022, The University of Hong Kong demonstrated a flexible haptic feedback system that sticks to the palm and front of the fingers, connected to a small battery and Bluetooth communication system on a small patch on the forearm. ^M Force feedback gloves from companies like Teslasuit and Dextra Robotics create resistance to a user's finger movements using an exoskeleton when they attempt to grip a virtual object. ^{HH} With so many different independently developed technologies, it is likely that they will merge to create a multimodal sensory feedback experience.

Despite the high price point, crowdsourcing, and crowdfunding, will significantly reduce the cost of future haptic devices, making them widely available. The commercially available tactile feedback gloves are prohibitively expensive for most users. Teslasuit force feedback gloves start at USD 15 thousand, and a Haptix system is over USD five thousand with an additional USD 500 monthly subscription. Driver-X's dual-purpose gloves are crowdfunded, which reduced the projected price point to USD two thousand. ^M Open developers like Openglove.org and LucidVR are democratizing the technology. LucidVR developed a fully functional dual-

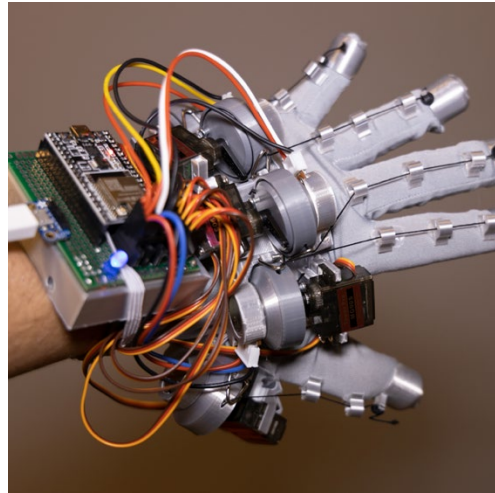


Figure 29: Lucid VR Prototype 4

purpose force feedback and tracking glove for USD 30 using commercially available electronics and 3D-printed parts. LucidVR also maintains crowd sourced code for integration and firmware, designs for 3D parts, and video tutorials for laymen. ^H Ultraleap does not offer its ultrasonic haptics directly to the public but Emerge crowdsourced its device and offered it for a retail price of USD 500.

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Michael A. Mignano

Advances in Geographic Mapping for Virtual Environments Will Most Likely Support the Next Large-Scale Military Operation

Executive Summary

Commercial Virtual Training Environments (VTE) will most likely (71–85%) support future military operations by providing geographic mapping capabilities for the next large-scale operation. Advances in 3D mapping, Light Detection And Ranging (LiDAR) mapping, and big data mapping will most likely allow the military to customize needs based on an adversary's location. Despite VTE not providing the same hands-on experience as real-time training, geographical mapping can increase speed and efficiency in military readiness by eliminating the need for travel, materials, and facilities.

Discussion

3D mapping is a process that utilizes machine learning algorithms to profile objects and create a 3-dimensional view map into the virtual world. [M](#) The move to 3D mapping is part of a technology race among developers for ever greater realism in applications ranging from gaming to virtual reality. [M](#) 3D maps allow for the visualization of space intuitively and naturally, allowing for faster and more efficient decision-making and analysis in

several fields, including Defense & Security, Geo-Intelligence, Disaster Management & Emergency Response, Infrastructure Management, Smart Cities, and Automotive. [M](#) Most importantly, 3D mapping offers modern technical data collection and visualization methods. [M](#) Knowledge visualization and science mapping are more straightforward when a 3D map of the location allows analysis. [M](#) A mainstay of 3D maps is that they provide analytical data that – through

simulation -- can be used to help predict outcomes and make evidence-based decisions. [M](#) The evolution of 3D mapping is rapidly growing together with the applications developed to use it, especially in surveying and material. [H](#) The subsequent development of 3D maps will likely involve more precise indoor mapping technology, the use of various technologies to determine the location of a device indoors. [M](#) Location-based augmented reality is another technology that is rapidly advancing and has the potential to transform indoor environments into immersive augmented reality/virtual reality experiences. [M](#) There is little doubt that 3D maps are the way of the future of mapping, and there are numerous

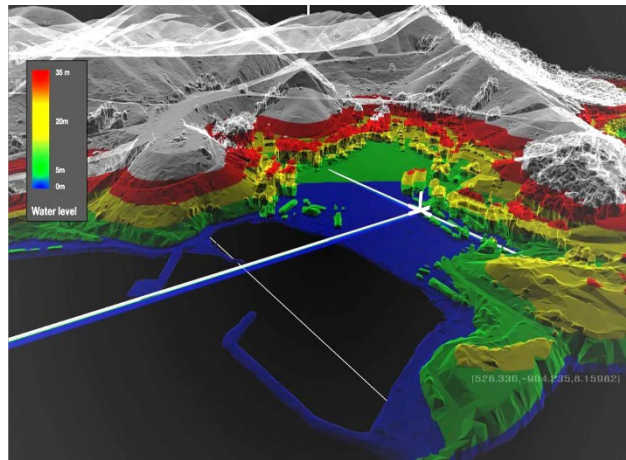


Figure 30. New technology can create an incredibly detailed and accurate 3D map of a battlefield.

advantages and possible uses for them that will be essential in assisting us in navigating and better comprehending our environments. [M](#)

LiDAR technology utilizes pulsed lasers to accurately and constantly measure distances to a target or area. [H](#) Various industries, including automobiles, robots, drones, smart cities, logistics, and road repairs, use the technology. [M](#) As technology continues to improve and costs decrease, the applications are likely to increase dramatically. [M](#) The accuracy and completeness of the information provided by LiDAR make it an essential tool for surveying and mapping professions. [M](#) Corridor mapping is one example where the technology can provide high-fidelity visualization that is needed. [M](#) LiDARs combined with the Internet of Things will help create "SMART cities" by improving the data that exists as well as providing real-time measurements. [M](#) The LiDAR market for automotive applications will grow to USD eight billion by 2033. [M](#) The demand for these systems in the automotive industry will drive the market's growth. [M](#)

Big data mapping is [the](#) process of inputting data layers into a Geographic Information System (GIS) to produce a map, providing users with legible information that raw data can't display on its own. [M](#) Big data mapping has evolved into a means for data sharing and collaboration, inspiring a vision that is now rapidly becoming a reality—a continuous, overlapping, and interoperable GIS database of the world. [M](#) The increasing need to collect, visualize, and analyze spatial data is the biggest driver behind the phenomenal growth of these systems in the coming years. [M](#) Big data has the power to improve GIS software, leveraging vast amounts of data to generate meaningful results. [M](#) The use of big data mapping will alter as technology develops. The technology is evolving to work across applications and systems, including smartphones, web browsers, and cloud environments. [M](#) As people continue to use AR and VR more frequently and become more accustomed to the technology, more developers will incorporate GIS capabilities into their products. [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable, numerous, and corroborative. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to innovation in capabilities and information.

Author: COL Robert J. Shadowens

Software Advancements Will Highly Likely Revolutionize Virtual Reality Training in the Next Decade

Executive Summary

Software advancements will highly likely (71-85%) revolutionize Virtual Reality (VR) training in the next decade. Light field displays, haptic feedback, and holographic telepresence software will likely change VR experiences, making them more realistic, immersive, and interactive. VR adoption and development barriers include user comfort, safety, privacy, and human health. Despite these concerns, continued investments, research, and governing practices will highly likely make VR the preferred future training mechanism.

Discussion

Light field displays represent the 3D geometry of all the objects in a scene, which requires much more data than 2D video. [M](#) Advances in light field display software will improve virtual training by creating a more immersive environment that offers users more realistic gamification of their training and eLearning. [M](#) Displays are an attractive feature of VR in medical education as they provide an immersive environment capable of simulating clinical experiences. [M M](#) The future of this technology lies in its ongoing integration into curricula and with technological developments that allow shared simulated experiences. [M](#) Light field displays can replace any 2D screen, making them ideal for virtual training applications. [M](#) Advances will help with depth perception, reduce motion sickness, enhance realism, improve interactivity, and provide an expanded field of view. [M M M](#) According to estimates, 40 percent of people experience motion sickness, with women being more sensitive than males. [M](#) However, recent research shows that inexpensive light field displays driven by 4D prefiltering algorithms can produce the desired results. [M](#)

Haptic feedback is a technology that uses tactile sensations to give users a sense of touch and feel in response to digital stimuli. [M](#) The global haptic technology market is likely (56-70%) to increase at a Compound Annual Growth Rate (CAGR) of 12 percent. [M](#) The technology can simulate natural work environments and labor conditions with improved accuracy, allowing users to partake in virtual training scenarios and get a lifelike experience in a safe, offline environment. [M](#) It can also provide realistic and immersive sensations that support multisensory learning, enhancing online learning outcomes. [M](#) The latest technologies significantly improved training and learning, and the next stage of development is to replicate the feel of objects in the virtual environment using haptic technology. [M](#) Feedback is indispensable for enhancing VR systems' immersion, interaction, and imagination, making it an essential tool for virtual training applications. [M](#) Advances in this area will increase the effectiveness of virtual reality training simulations. [M](#)

Advancements in holographic telepresence systems can significantly improve VR training adoption and development by providing an immersive and interactive learning experience. [M](#) [M](#) The development of this technology enables experts to deliver lectures across different locations and facilitates real-time interaction among individuals, adding a new dimension to education and training. [M](#) The recent advancements in AI that enabled real-time 3D hologram creation are likely to significantly improve the accessibility of VR training and facilitate the creation of holograms for various applications such as 3D printing and medical imaging. [H](#) The global holographic imaging market valued at USD 554 Million in 2020, with a forecasted CAGR of 30 percent from 2021 to 2028 and a revenue forecast of over USD four billion by 2028. [M](#) Advances in this capability will allow users to view their structures and models in 3D form and learn about the intricacies of their subjects more accurately. [M](#)



Figure 31: Holographic projection of VIP in London interacting as a hologram in NYC.

VR improved recently, but the technology still faces significant adoption and development barriers. One of the most critical factors is user comfort, which is essential for creating a seamless experience that does not cause discomfort or motion sickness. [M](#) [M](#) Another concern is safety, particularly when users immerse themselves in a virtual environment that alters their perception of reality. [M](#) The potential to abuse personal information and behavior in VR environments raises serious privacy and data protection concerns. [M](#) [M](#) Finally, there are concerns about the impact of VR on human health, including issues such as eye strain, headaches, and neck pain. [M](#) [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable, numerous, and corroborative. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst used artificial intelligence to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to innovation in capabilities and information.

Author: COL Robert J. Shadowens

Data Requirements Will Highly Likely Transform Wireless Network Architecture Within The Next Ten Years

Executive Summary

Data requirements will highly likely (71-85%) transform wireless network architecture within the next ten years due to advancements in 5G/6G, low-orbit and high-throughput satellites, and Quantum networks. Despite these technologies' high cost and infrastructure challenges, the increased demand for data-hungry devices will force implementation.

Discussion

Today's wireless networks are inadequate for the demands of emerging technologies like autonomous vehicles, smart devices, and augmented reality. [M](#) [M](#) The number of connected devices will likely reach 56 billion by 2025, requiring over 73 trillion gigabytes of data, new advances in data transfer and network technology will be necessary to manage it. [H](#) Network function virtualization and software-defined networking increase network reliability by converting specialized hardware or local virtual machines into cloud-based software. [M](#)

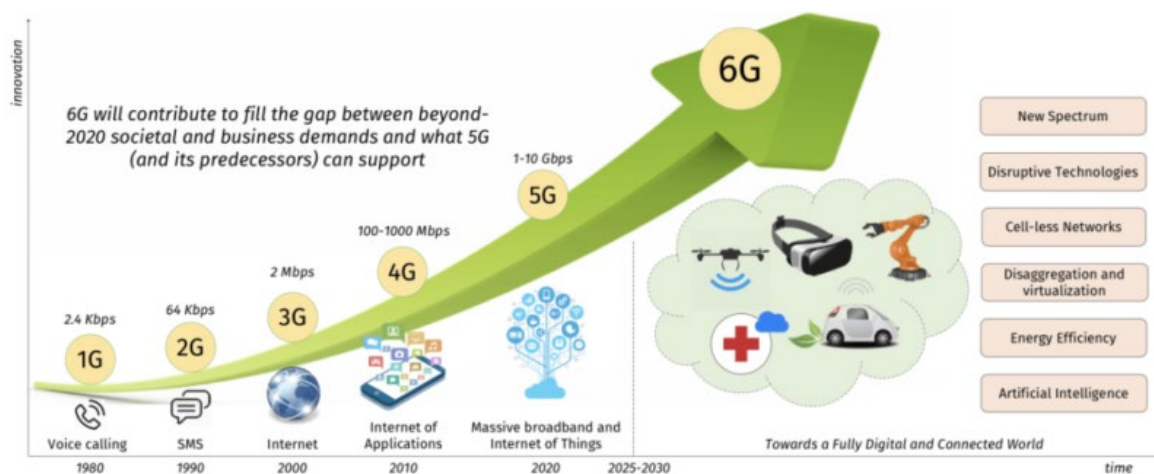


Figure 32: 5G Network

By 2025, the deployment of 5G Advanced is expected and will expand the technological and network upgrades on the current 5G network. [H](#) A key component of 5G Advanced is integrating artificial intelligence (AI) and machine learning (ML) solutions to enhance network management capabilities, enabling higher download speeds while maintaining low latency. [H](#) The 6G wireless communication network is set to launch in 2030 and will improve reliability, reduce connection drops, and allow connected devices to use multiple connections concurrently, which is critical for supporting advanced technologies like drones and robots. [H](#) Advanced AI systems and powerful edge computing will use 6G's faster speed to coordinate with complex systems and develop seamless internet

connectivity. ^M 6G will be 100 times faster than 5G and have a peak data throughput of 1 thousand gigabits per second with enhanced dependability and expanded network coverage. ^M

LEO satellites operate between 500 and 2,000 kilometers above the Earth's surface, and they significantly reduce latency by better positioning themselves to receive and transmit data due to their low orbit. ^M By augmenting networks with low-orbit and high-throughput satellites, it is possible to achieve seamless coverage and form a patchwork quilt consisting of overlapping terrestrial and non-terrestrial networks, providing reliable coverage to 95 percent of the earth's surface and allowing for the internet to advance further. ^M The Quantum Internet is envisioned as the pinnacle of the network revolution, promising significant improvements in data transmission efficiency, network security, and information processing capability. ^L Experts estimate that the United States will establish interstate Quantum networks within 10 to 15 years. ^M David Awschalom, the director of the Chicago Quantum Exchange, believes that the Quantum internet marks a paradigm shift and enables the transmission of unhackable encrypted messages and the resolution of complex problems by establishing an entangled network of advanced computers. ^M

Proponents of 6G and other emerging technologies are likely (56-70%) to balk at the high costs and infrastructure challenges, but it is highly likely that the commercial nature of the industry, and the need to stay ahead of the near-peer competition, will drive entire adoption cycle. ^M Despite the high costs and infrastructure challenges, advocates for these technologies expect to push for their adoption for faster data speeds, lower latency, and improved connectivity. ^M Businesses and governments will likely prioritize investment in these technologies to maintain their competitive edge. ^M

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, and the analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ perplexity.ai) to visualize and scope the problem and reliable source information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Keith S. Vanyo

Optimized Logistics

USAR Is Highly Likely To Decentralize Premobilization Administrative and Medical Tasks Within the Next Ten Years

Executive Summary

The USAR is highly likely (71-85%) to decentralize premobilization administrative and medical tasks within the next ten years due to collaborative AI and telemedicine advancements. Despite these technologies' high cost and cultural challenges, the increased demand for a more efficient and rapid premobilization will force implementation.

Discussion



Figure 33: It takes a village to mobilize today's Army

In Aug 2020, the U.S. Army surveyed over five thousand soldiers and found that only 14 percent believed their unit was fully prepared to deploy, and much of this readiness is the responsibility of the SRP (Soldier Readiness Processing). [M](#) SRP is a process that prepares Soldiers for mobilization, deployment, and demobilization and includes medical, financial, and legal packets that Soldiers need to complete before deployment. [H](#)

However, the SRP process can be slow and recent initiatives are looking to enhance the experience through a virtual process. [M](#) [M](#)

It is highly likely (71-85%) that advancements in collaborative AI will revolutionize the military process as companies compete to develop and fund research, advanced technology, and enhanced capabilities. [H](#). Collaborative AI progress will revolutionize military defense with its implementation in various military applications such as logistics and battlefield healthcare. [M](#) AI can address the current shortage of healthcare personnel by enhancing the treatment process's effectiveness and decreasing the number of doctors required for a particular care episode. [M](#) Improvements in virtual reality technologies, including more processing power, improved screens, richer audio, and better ergonomics, will propel VR from a niche capability to the predominant decentralized collaborating tool. [H](#) Furthermore, VR technology will transform how dispersed teams collaborate over the next decade by improving collaboration, eliminating bottlenecks, enabling lean delivery, and enhancing project delivery. [H](#)

Telemedicine's popularity is rising due to the accessibility of digital patient data, the high expense of traditional care, and regulatory easing within the healthcare sector. [M](#) With electronic medical records and other forms of digital data, doctors can now diagnose and

treat patients remotely with greater efficiency and accuracy. [M](#) The military is also embracing telemedicine's enhancing capabilities. Remote medical services have already proven highly beneficial for military personnel stationed in areas or situations where medical professionals cannot be physically present. [M](#) By utilizing healthcare providers beyond confined locations or posts, the Army can optimize its use of this scarce resource and potentially save costs. [M](#) As the demand for telemedicine continues to grow, it is highly likely that the U.S. Army will continue improving its capabilities and benefits. [M](#)

Telemedicine and collaborative AI require dependable network connectivity, which may not always be available. [M](#) Technical challenges might also result from problems with interoperability between various software programs and hardware. [H](#) Despite these and the high costs and infrastructure challenges, advocates for advanced technologies expect to push for their adoption and improved connectivity. [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, and the analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ perplexity.ai) to visualize and scope the problem and reliable source information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Keith S. Vanyo

Artificial Intelligence and Machine Learning Will Synchronize Movements Enabling Future Mobilization

Executive Summary

It is almost certain (86-99%) that advances in Artificial Intelligence (AI), Machine Learning (ML), and autonomous transportation systems will enable the components of large-scale mobilization operations within the homeland. Due to the high demand for marshaling and movement of resources, enhanced automated processes and data analysis will prioritize military movements and a whole-of-nation mobilization effort. Despite current cyber and information vulnerabilities in the U.S. transportation automation network, projected advances in intrusion detection systems, phishing detection systems, and improved encryption will allow the mobilization enterprise to detect and respond to threats, ultimately enabling large-scale mobilization.

Discussion

Suppose Great Power Competition (GPC) with one or multiple peer adversaries leads to Large Scale Combat Operations (LSCO). In that case, the large-scale mobilization of the reserve component will facilitate combat operations across all domains. For example, the United States transportation industry faced a massive demand during Operation Desert Storm. Even against a relatively weaker adversary, the transportation industry still required 459 ships to transport 9.2 million tons of cargo. ^H Thousands of convoys and rail movements required meticulous synchronization, but often in-transit visibility was lacking. ^H Although a full mobilization significantly strains the throughput on the Nation's mobilization infrastructure (highways, ports, rail) and will require a massive transportation effort, ^H AI and ML will provide the mobilization enterprise better visualization and facilitate movement.

The Department of Defense's ability to project combat power from "Fort to Port" is enabled through the Department of Transportation (DoT), the Strategic Highway Network (STRAHNET), the U.S. rail system, and our numerous air and sea ports. The mobilization transportation enterprise consisting of Surface Deployment and Distribution Command, military installations, ports, U.S. Department of Transportation, Federal Highway and State Highway administrations, and the Federal Rail Administration, in conjunction with commercial contractors, will ensure the readiness and modernization of the transportation network for national defense. ^M This network is in a continuous cycle of automation improvement that incorporates AI and ML into operations. ^M In 2022, the transportation industry invested around USD 6.2 billion in artificial intelligence and machine learning, with a projected compound annual growth rate of 41 percent between 2019 to 2026. ^M In a massive mobilization, this network will ensure military priority within the system and ensure optimal use of the entire system. ^M

AI and ML are already in use throughout the transportation sector, and the industry is one of the leaders in AI/ ML and cyber security innovation and implementation. ^H The U.S. Military will benefit through this evolutionary technology's gradual, incremental, and continuous improvements. ^M Positive outputs of AI and ML applications in practice within the transportation sector include maintenance forecasting, traffic control mechanism, staff management, the use of autonomous cars, trucks, and ships, and most notably, smarter logistics functions. ^M The industry continues to improve its ability to track real-time sensor data regarding traffic, weather, and waiting times to efficiently and smartly direct logistics, which will ensure prioritization and efficiency of military movements in the event of large-scale mobilization. ^M

It is highly likely (71-85%) that the next mobilization will occur in a contested homeland. ^H Using the war in Ukraine as an indicator for future conflict, both sides have effectively slowed the other's movements through the kinetic and cyber targeting of transportation networks. ^M Ukraine successfully slowed, and in some cases stopped, Russian troop and logistics movements through targeted attacks on the rail and road networks. ^H In future conflicts, adversaries will almost certainly (86-99%) continue targeting transportation networks through the cyber and information domains. Despite adversary attempts to infiltrate the transportation network, new regulations and advances in machine learning will close human process loops by enabling threat prioritization, detecting intrusion and phishing, and improving encryption. ^H



Figure 34: How the Future of Cyber Security depends on AI/ML

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. In the preparation of this report, artificial intelligence (ChatGPT) assisted the author in problem visualization and scoping.

Author: LTC Robert (Bob) McTighe

New Transportation Modes, Autonomous Vehicles, And Digital Passports Highly Likely To Expedite Travel Within Ten Years

Executive Summary

The movement of people and military units will highly likely (71-85%) increase in speed and efficiency within the next ten years due to advances in hyperloop transportation, connected and autonomous vehicles, and digital identification documentation. From a large-scale mobilization standpoint, this implies rapid aggregation, military movements, and multi-tasking of pre-deployment training requirements. Despite these technologies' high costs, safety concerns, and security issues, the desire for faster movements, convenience, and greener environments will drive their simultaneous implementation.

Discussion:

In 2013, Elon Musk published a 58-page technical paper describing the “hyperloop,” a solar-powered transportation system that can travel up to 760 mph using magnetic levitation inside a vacuum tube. [M](#)

Since then, private investments in this “5th Mode” of transportation include a 2020 Virgin Hyperloop prototype test. [H](#)

Moreover, the 2021 USD two trillion infrastructure bill includes hyperloop technology and infrastructure development, which will enable companies to compete for and access funding usually used for the growth of traditional modes of transportation. [H](#) It is highly likely (71-85%) that small-scale inter-city projects will be commercially available by 2026. [M](#) However, extremely high implementation costs, continued testing requirements, regulatory hurdles, and construction time will significantly delay widespread use. [H](#) Despite those hurdles, metropolitan congestion, changing climates, congressional backing, and a strong desire for a faster, cheaper, weather-immune transportation method will continue to move this technology forward. [H](#) As this 5th transportation mode evolves, it is likely (56-70%) that this mode of transportation, offered nationwide, will rival or surpass already established transportation modes between 2035 and 2040. [M](#)



Advances in computing power, sensors, and machine learning will inspire continued growth in the foreseeable future throughout the Connected and Automated Vehicles (CAV) industry. [M](#) By 2030, the autonomous vehicle industry will increase from USD 4 to 186 billion dollars annually. [H](#) It is highly likely (71-85%) that this incremental capital increase

will yield fully autonomous cars by 2030. [M](#) Consumer acceptance of these new technologies, federal, state, and local regulations, high costs, and availability of materials are all major implementation hurdles. [H](#) Despite these issues, the projected advancement of CAV will yield long-term positive effects on the transportation industry and, by extension, military mobilizations. [H](#)

Most countries worldwide require the U.S. military to obtain a passport prior to entry. [H](#) Even expedited military passport processing timelines are at least 6-8 weeks. [H](#) Ukraine now uses a “state in a smartphone” technology, and Australia and the United Arab Emirates use similar technology. [H](#) [H](#) It is highly likely (71-85%) that the United States will adopt a similar passport and document system within the next ten years to simplify international travel. [H](#) Since 2006, U.S. passports included a biometric chip; the smartphone passport is the next logical step. [H](#) A digital passport reduces processing times and facilitates faster border crossings. [H](#) However, security concerns, implementation costs, and fair accessibility may prevent the implementation of this concept. [M](#) Despite these concerns, blockchain technology will highly likely ensure secure use through its distributed nature and advanced cryptography. [H](#) To address accessibility concerns, the U.S. will almost certainly make special cases for traditional passports to ensure fair travel is accessible to all. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were reliable and tended to corroborate one another. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ elicitor.org) to visualize and scope the problem and source reliable information.

Author: LTC Robert (Bob) McTighe

The USAR Will Likely Have Fewer Soldiers to Deploy in Support of 2035 Worldwide Operations

Executive Summary

By 2035, the United States Army Reserves (USAR) will likely (56-70%) have 30 percent fewer soldiers to support Large Scale Conventional and Irregular Operations. This is due to the decline in recruits, a poor retention rate, and the USAR force structure. Despite the USAR's high level of individual readiness, the number of deployable soldiers will decline.

Discussion

The Army fell short of meeting their recruiting FY2022 recruit goal by approximately 29 thousand soldiers. The USAR has missed its recruiting goal for the last three years; in FY20, it fell short by 2,144 soldiers, and in FY21, they were short by four thousand soldiers. ^H All indications suggest the Army Reserves will likely miss the FY2022 goal by at least two thousand soldiers. The Army historically has an attrition rate of ten percent per year. ^H Based on the decline in recruits and the ten percent attrition rate, the USAR 2035 end strength will likely be 164 thousand soldiers. This projection is a linear extrapolation from the USAR's January 2023 strength report.

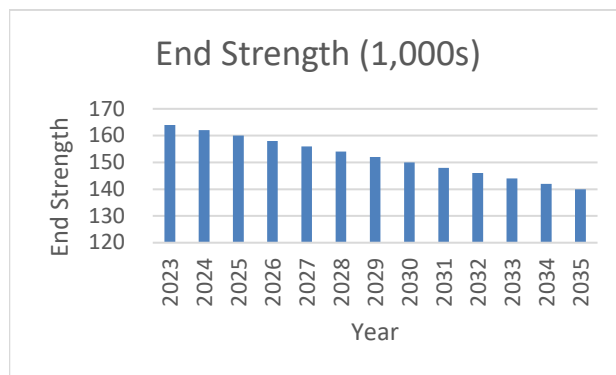


Figure 36: United States Army Reserves End Strength.

The USAR end strength does not reflect the number of deployable Soldiers within the reserve component. A review of the sk organization illustrates that many of the soldiers are on active missions, support roles, and administrative functions. ^M Combining this with the USAR's January 2023 strength reports indicates that approximately 33 percent of the soldiers are in positions not intended to deploy. ^H The USAR's structure reduces the number of deployable soldiers to support military operations abroad to approximately 94 thousand soldiers.

The training pipeline further reduces the available soldiers. Soldiers are not fully deployable when they finish their initial training. ^M In FY2021, the USAR recruited nearly 12 thousand soldiers ^H If the reserves maintain the same level of recruitment over the next 12 years, this will leave the pool at approximately 82 thousand soldiers available to deploy. Finally, on average, ten percent of the soldiers will not maintain their readiness levels, which reduces the available number to 75 thousand.

Despite the USAR's high level of individual readiness, only 75 thousand reservists will be deployable soldiers in FY2035. The Reserves maintains between 90 – 95 percent individual readiness levels nationwide. [H](#) Individual readiness considers temporary injuries, medical conditions, and other miscellaneous factors.

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL John C. Haas, Jr.

Autonomous Technologies Will Likely Revolutionize Military Logistical Transportation Within 10-15 Years

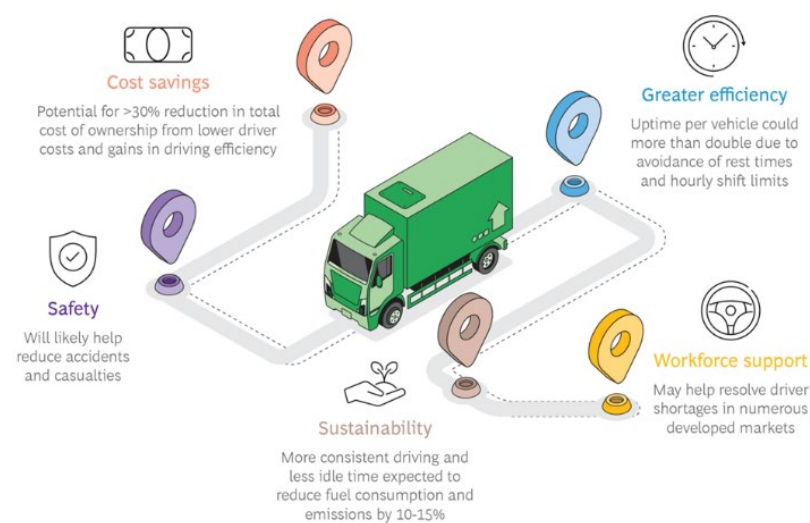
Executive Summary

Advancements in autonomous technology will likely (71-85%) revolutionize logistical transportation in the next 10-15 years and rapidly change military sustainment due to autonomous trucks, vessels, and drones. The next great revolution in warfare will be autonomous technology. Despite the cybersecurity risks, safety concerns, and changes in international laws required to govern their use.

Discussion

Changing driver demographics and expected freight volume growth will yield a 160-thousand-person truck driver deficit by 2030. [M](#) U.S. companies are looking towards autonomous trucks to fill this capability gap and transform the logistics industry. [M](#) According to Next Move Strategic Consulting, the global autonomous vehicle market is forecasted to reach USD two trillion by 2030. [H](#) Autonomous trucks will initially operate in a hub-to-hub configuration, with human drivers managing route endpoints such as congested urban streets while autonomous trucks will service the highways. [H](#) Additionally, technology advancements like 5G will enable real-time vehicle and road traffic communication, and data sharing will allow vehicles to operate safely across the entire network. [M](#) This technology will fundamentally alter Army sustainment by delivering combat-sustaining ammunition, rations, and repair parts to future battlefields via autonomous resupply convoys. [M](#)

Exhibit 1 - Autonomous Commercial Vehicles Offer Major Potential Cost, Efficiency, and Workforce Benefits



Source: BCG analysis.

Figure 37: Autonomous Commercial Vehicles Benefits

Companies are also beginning to consider drones as logistics vehicles. The global commercial drone market will likely reach USD 30 billion, with a Compound Annual Growth Rate (CAGR) of 39 percent expected between 2023 and 2030. [M](#) Due to their versatility, effectiveness, and speed, drones will claim significant urban deliveries by 2030. [M](#) Drones could meet the growing demand for residential delivery as customer expectations from online shopping spread to sectors other than retail. [M](#) Amazon, UPS, and Walmart have already added drone delivery services to their platforms, and the global market for drone-delivered packages will highly likely reach USD eight billion by 2027. [M](#) Zipline, a new unmanned aircraft logistics startup, promises deliveries directly to patients' homes in as little as 15 minutes. [M](#) Moreover, a drone delivery service has up to 70 percent lower operating costs than a vehicle delivery service mode. [M](#) Additionally, modernizations in military logistics include incorporating drones like the Tactical Resupply Unmanned Aircraft Systems (TRUAS) to improve supply chain management. [H](#) These systems can transport up to 400 pounds while flying at a speed of 55 nautical miles, enabling more efficient and safer resupply of troops in the field. [H](#) [M](#) [H](#)

By 2030, the autonomous ship market will transform logistics and highly likely reach USD 134 billion. [M](#) Technology is rapidly advancing, and Samsung Heavy Industries stated in November 2022 that it had successfully tested an autonomous ship for more than 500 nautical miles in coastal waters. [M](#) Additionally, Hyundai Heavy Industries announced plans to launch a remote-controlled vessel by 2025, followed by a fully autonomous ship by 2030. [M](#) Finally, human error accounts for over 75 percent of maritime accidents. However, autonomous ships will significantly improve safety and efficiency by eliminating the need for crew members, changing the future of military resupply. [M](#) [M](#) Although autonomous logistical transportation systems have many benefits, they pose potential hazards and safety issues. [M](#) Companies involved in creating self-driving equipment will need skilled experts to protect their products from cyber threats and changes in laws that regulate their use. [M](#) Designing and implementing robust security measures will be crucial for these experts in ensuring the safety and security of autonomous systems. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, and the analyst worked alone, but used AI (ChatGPT/perplexity.ai) to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Keith S. Vanyo

Intelligent Technologies Will Highly Likely Transform How the U.S. Forest Service Mobilizes In The Next 10-15 Years

Executive Summary

Intelligent technologies will highly likely (71-85%) transform how the U.S. Forest Service mobilizes and fights forest fires over the next 10-15 years. Due to rapid advancements in satellite, autonomous devices, wearable technology, and artificial intelligence (AI). Despite the cost of infrastructure upgrades and firefighting historically being technology-averse, changing climate conditions and human activities have generated an urgent need for intelligent technologies.

Discussion

Firefighters battle an average of 60 thousand wildfires nationwide each year, and the risk of wildfires is constantly rising. [M](#) When wildfires break out, the U.S. Forest Service relies on the National Interagency Fire Center's antiquated system to mobilize crews, aircraft, and equipment from various geographical areas. [M](#)



Figure 38: Working Age Population Projection

According to a recent Environmental Program report, wildfires will increase by 50 percent by the year 2100. [M](#) To combat this challenge, The National Oceanic and Atmospheric Administration (NOAA) uses satellite-based early wildfire detection to provide first responders with the initial location of fires so they can fight them more quickly. [H](#) Using satellite and predictive analytics can forecast the evolution of a fire and improve situational awareness. [M](#)

According to the U.S. Forest Service, aviation is responsible for 24 percent of all wildland firefighter fatalities. [M](#) Drones demonstrate significant advantages over traditional human-piloted firefighting aircraft, and their capabilities continue to grow. [H](#) Descartes Lab is developing drones to drop up to 450 incendiary devices in four minutes to designated control burn areas. [H](#) Additionally, Unmanned Aerial Vehicles (UAVs) can provide georeferenced aerial images, heat maps, and temperature scales of fire zones. Drones with specialized capabilities can even transport hoses to inaccessible locations. [M](#) Lastly, monitoring wildfires and detecting their spread could one day be accomplished by employing swarms of autonomous drones. [M](#)

Wearable sensor technology in the fire service will significantly reduce the risk of search and rescue operations and the health and safety of firefighters. [M](#) It will enable real-time physiologic health and wellness monitoring of firefighters via vital signs. This technology will allow them to track their location, speed, and direction of travel. [M](#) The ultimate objective of wearable technology is to utilize this data and provide near-real-time information to the incident commander (IC), who can make better decisions about the safety of the members operating on the scene. [M](#)

AI will significantly improve firefighting efforts by offering better predictions, resource allocation, and preventative methods. [H](#) Random witnesses or airplane pilots typically report most fires today, resulting in fires lasting hours or days before mobilizing resources. [H](#) Descartes Lab further attempts to reduce that delay by training its software to detect fires before they erupt. [M](#) Machine learning algorithms can analyze satellite imagery, weather patterns, and other data to predict a wildfire's early warning signs, trajectory, and severity. [M](#) Despite the cost, intelligent technologies and predictive analytics will significantly improve U.S. Forestry capabilities and save lives by detecting fires earlier. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL Keith S. Vanyo

Additional Findings

USAR Will Highly Likely Face Significant Resistance As It Implements Decentralized Mobilization by 2035

Executive Summary

The USAR will highly likely (71-85%) face procedural and cultural obstacles as it implements decentralized mobilization enhanced with XR and AI by 2035. The resistance is due to the established processes, doctrine change, and low trust in AI. The USAR will resist implementation despite the steady advances in XR and AI in private industry.

Discussion

The mobilization process has remained an eight-step process for the last three decades. [H](#) In 2009, the Army issued Execution Order 150-08, defining pre and post-mobilization training roles and responsibilities; premobilization training tasks, including documentation requirements and standards; and an integrated deployment training process. [H](#) The order states that First Army is responsible for executing training and readiness oversight authorities over Reserve Component forces and validating units ready for deployment. [H](#) The decentralized mobilization model will eliminate steps 4 and 5.

Units preparing for deployment strive to be T (fully trained) on most Mission Essential Tasks (METs). [H](#) To fully train on a MET, 75 percent of the soldiers must be physically present and observed by the 1st Army to achieve deployment qualification credit. [H](#) Army leaders consider this live fire training the most effective way to generate confidence and trust among leaders, teammates, and soldiers. [H](#) The decentralized mobilization process will remove the live training, [H](#).

Low trust in AI is due to the lack of transparency, bias in data, and missing safety/alignment protocols. [H](#) Lack of transparency refers to the difficulty in understanding how artificial intelligence systems make decisions. [H](#) For example, a model will find a pattern that most humans do not see or understand, which makes the model appear to act unpredictably. [H](#) In 2018, Amazon's recruiting engine taught itself that male recruits were preferable based on Amazon's historical hiring data. [H](#) The recruiting engine learned biases from the data and amplified them, despite the impartial programming. [H](#) The Amazon recruiting engine bias also reinforced the public concern that machine learning will commit harmful behavior that emerges from incomplete program objectives. [H](#) Currently, there are no US or international standards to enforce AI safety/alignment and prevent dangerous behavior. [M](#)

USAR will resist implementing the decentralized mobilization process despite the steady advances in XR and AI in private industry. VR/AR literacy will be highly likely (71-85%) widespread in American society within ten years due to commercial retail, education applications, and gaming growth. [H](#) Advances in collaboration tools are highly likely (71-

85%) to enable decentralized mobilization activities within the next 5-10 years. [H](#). Extended Reality (XR), holograms, and brain-computer interfaces (BCI) will change VR capabilities and improve team proficiency and productivity. [H](#)

Analytic Confidence

The analytic confidence for this estimate is *moderate*. Sources were generally reliable and tended to corroborate one another. There was adequate time, but the analyst worked alone and did not use a structured method. The analyst worked alone but used artificial intelligence (ChatGPT/ you.com/ elicitor.org) to visualize and scope the problem and source reliable information. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: COL John C. Haas, Jr.

Successful Proxy War In Ukraine Suggests Standard Mobilization Windows In Future Great Power Conflict

Executive Summary

The War in Ukraine demonstrates that sustained and focused pre-combat partnerships, coupled with rapid fielding of intuitive weapon systems, will likely (56-70%) support standard mobilization windows for U.S. forces in a future conflict with a peer competitor. Due to innovative mobilization, recruitment, training techniques, and the rapid fielding of intuitive and advanced weapon systems, Ukraine successfully repelled Russian attacks for the first year of this war. Despite the perceived need to expedite mobilizations and the general “fight tonight” mindset within the military, the Ukrainians proved that a relatively weaker force with global backing could facilitate a methodical, deliberate, and prioritized U.S. mobilization process.

Discussion:

In February 2022, the Armed Forces of the Russian Federation (AFRF) maintained a 12:1 troop advantage over the Ukrainian Armed Forces (UAF) north of Kyiv, yet Ukraine still repelled the invasion. ^H Three mutually supporting actions: the readiness level of Ukrainian forces, the whole-of-nation approach to mobilization, and the rapid fielding of equipment demonstrated this model’s utility in future conflict and supports traditional U.S. mobilization systems and timelines.

The most significant UAF combat enabler is the UAF’s effective building and modernization of their conventional, reserve, and Territorial Defense Forces (TDF) since the 2014 initial Russian invasion. ^H Ukraine has been at war for over seven years, gaining valuable combat experience despite the limited scale of the conflict. ^H Also, since March 2015, the Joint Multi-National Training Group – Ukraine (JMTG-U) provided practical combat training experience and equipment fielding to over 23 thousand Ukrainian soldiers before the invasion. ^M The partial Russian occupation and persistent threat drove the military training partnership and modernization of the UAF. ^H



Figure 39: Ukrainian volunteers mobilize as part of Territorial Defense Forces (TDF) to defend country

The whole-of-nation call to arms and nationwide support of the UAF defense enterprise enabled the mobilization. Thousands of volunteers augmented Ukraine’s newly established

TDF, who all operated under a very loose intent to defend the country against the AFRF. [H](#) Civilian dynamism and enmity toward Russia, coupled with a global outpouring of equipment, intelligence, and financial support, created a combat multiplier. [H](#) When viewed through the same lens as the simultaneous military mobilization, this multiplier positively shaped the initial stages of the conflict. [H](#)

Rapid fielding of advanced weapons also significantly impacted the UAF's initial success. Although displaced from Lviv in February 2022, the JMTG-U provided the framework to field new equipment to the Ukrainians to sustain operations rapidly, continue to repel Russian attacks, and in some cases, execute counter-offensives. [M](#) The initial fielding of equipment, such as Stinger missiles, Javelin rockets, and small UAS systems, allowed UAF to disrupt and delay advancing AFRF aviation, tanks, and c2 nodes. [M](#) These weapon systems are intuitive and require very little training, making their implementation on the battlefield fluid. [M](#) As the conflict progressed, the U.S., its allies, and its partners provided heavier, more technical systems, mainly because there was no plan for a full coalition mobilization. [H](#) To facilitate future proxy wars and buy time for a full U.S. mobilization [H](#), DoD must increase global posture, stocks, and pre-positioning of these smaller and lighter systems. [H](#) Similar to Russia, China, and Iran both aim to keep the United States "out of their backyard" with an A2/AD strategy, but also like Russia, both are failing. [M](#)

According to Global Firepower's 2023 Military Strength rankings, which measure variables including the quantity of military, quality of equipment (technology), financial standing, logistics capability, and geography, [M](#) Russia possesses the second strongest military and Ukraine the fifteenth. Since the initial 2014 invasion, Ukraine has increased in the strength rankings, while Russia's maintained the same position. [M](#) Similar disparities in relative power exist between China and Taiwan. [M](#) With the above-listed enabling actions, Ukraine has fought to a relative stalemate despite Russia's overwhelming military power. Employing a similar strategy in other potential global conflict zones allows the U.S. and its allies crucial mobilization time. [M](#)

Analytic Confidence

The analytic confidence for this estimate is *high*. Sources were reliable and tended to corroborate one another. The analyst used the Alternate Competing Hypothesis method but worked alone. In preparing this report, artificial intelligence (ChatGPT/ you.com) assisted the author in problem visualization, scoping, and source identification.

Author: LTC Robert (Bob) McTighe

U.S. Mobilization Requiring Conscription Will Likely Result in Domestic Unrest

Executive Summary

The recent partial mobilization of Russia indicates that it is likely (49-65%) that a large-scale mobilization requiring conscription in the United States will result in domestic unrest due to American aversion to military service and opposition to conscription, despite public confidence of the U.S. Military. Despite popular domestic support for the war and military, partial mobilization of Russia's military resulted in widespread protests and a mass exodus of military-aged males. Like Russia, Americans have high confidence in their military as an institution, however, only a minority of Americans would recommend their children serve, and a vast majority oppose conscripted service. In the last five years, Americans from various political backgrounds routinely showed their willingness to create widespread domestic unrest over a variety of grievances.

Discussion

Prior to the invasion of Ukraine, the Russian government opinion polls indicated strong support for military service. According to the Russian Public Opinion Research Center (VCIOM), 68 percent of Russians said that they would like their son to serve in the Army, and 63 percent said that every man had an obligation to serve in the Army in December 2020. [L](#) In 2018, VCIOM studied Russian attitudes toward evasion of military service. They found that 56 percent of total respondents were either not likely to understand or likely to condemn citizens who evade military service. [L](#) The 2018 study found no significant age-related disparity among respondents but did find that urban respondents were significantly more likely to support or understand those who evaded military service. [L](#) In April 2022, two months after the invasion of Ukraine, 78 percent of Russians either somewhat or strongly supported the military operation. [M](#) In November 2022, after significant territorial and personnel losses, 74 percent of Russians still actively or passively supported military operations in Ukraine. [M](#)

Despite popular domestic support for the war and military, partial mobilization of Russia's military resulted in widespread protests and a mass exodus of military-aged males. On 21 September 2022, Russia announced a partial mobilization, requiring the conscription of an estimated 300 thousand Soldiers: by that evening, there were significant anti-mobilization rallies in 38 cities. [M](#) [M](#) Within a week of the mobilization announcement, recruiting stations in multiple cities were on fire, and a draftee shot a local draft board commissar six times in the chest. [M](#) [M](#) That same week, it is estimated that several hundred thousand Russians fled to neighboring countries to avoid military service. [M](#) Russia mobilized men who were too old, sick, unqualified, or otherwise exempt from the initial mobilization order. [L](#)

Like Russia, Americans have high confidence in their military as an institution (see Figure 1), however, only a minority of Americans support their children serving, and a majority oppose conscripted service. The U.S. Department of Defense Joint Advertising, Marketing Research & Studies surveys in 2020 revealed that about 65 percent of parents support their child entering military service, while only 38 percent recommend it. ^M A 2017 Gallup poll showed that 49 percent of Americans agreed with conscripting all young men and women to give at least one year of service to the Nation, but a significant disparity correlated to respondents' age. ^M Only 38 percent of 18- to 29-year-olds supported the idea compared to 66 percent of people over 65. ^M Americans highly opposed to military conscription even after attacks on the U.S. homeland. Between 1985 and 2007, the number of Americans who opposed a military draft remained between 69-85 percent. ^M

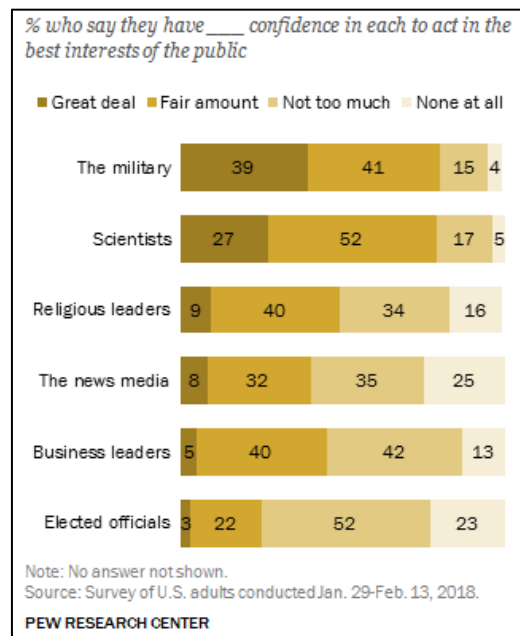


Figure 40: Confidence in U.S. Institutions

In the last five years, Americans from various political backgrounds routinely showed their willingness to create widespread domestic unrest. Recent instances include the protests and riots that followed the murder of George Floyd, the storming of the U.S. Capitol by supporters of President Donald Trump, protests and riots related to the Black Lives Matter movement, protests related to the COVID-19 pandemic, and the storming of Tennessee State Capital Building for tighter gun control regulations. The disparity in interests, income, and ages of the individuals involved demonstrate widespread domestic unrest can stem from various grievances in the US; the frequency suggests Americans are becoming more comfortable using the tactic.

Analytic Confidence

The analytic confidence for this estimate is *low*. Sources were generally reliable and tended to corroborate one another, however disinformation in foreign and domestic sources is widespread concerning the conflict in Ukraine. There was adequate time, but the analyst worked alone. Furthermore, given the lengthy time frame of the estimate, this report is sensitive to change due to new information.

Author: LTC Michael A. Mignano

Annexes

Annex A: Terms of Reference

Decisive Point 2035

For:

**MG Eugene J. LeBoeuf
DCG, United States Army Reserve Command**

By:

**Team LeBoeuf
USAWC**

21 November, 2022

Terms of Reference:

Requirement:

How can the United States Army Reserve (USAR) optimize the mobilization process to support large-scale combat operations in 2035?

- How does the enterprise optimize the pre-mobilization readiness level?
- What is required to maintain/build cohesive teams?
- What is required to leverage individual skills?
- What is required to optimize mobilization certification?
- What cultural obstacles will prevent the optimization of the mobilization process?

Methodology:

The team intends to gather information through various means, including but not limited to, data from open-source publications, interviews with industry practitioners, government agencies, intergovernmental organizations, and interest area experts. The team may recommend an adjusted training approach or new technologies if they determine a better model for collective unit training and individual preparedness is appropriate.

The team expects to execute this project using the following methodology (Note: timeline is notional and is subject to change):

- Parallel Data Collection (NOV22-FEB23):
 - Evaluate the current training model
 - Evaluate the expected training environment
 - Evaluate the expected training population
 - Explore existing methods and models used by governmental, intergovernmental, and industry practitioners
 - Explore existing and emerging technologies for training delivery
- Data Synthesis (JAN23-MAR23):
 - Identify recurrent best practices of existing models
 - Analyze best practices for optimization and adaptation
 - Develop a model or framework for optimized recommendations
 - Identify DOTMLPF-P gaps

- Develop potential DOTMLPF-P recommendations
- Solution Development (FEB-MAR23):
 - Compile a comprehensive report that includes the team's recommendations and simulated pragmatic application
 - Develop ancillary products, as needed, for concept demonstration and distribution
- Product Delivery (APR23):
 - The team will brief MG LeBouef

Challenges:

- Pre-mobilization training will conform to 10 U.S. Code Section 10147 – Ready Reserve yearly limitation of:
 - Forty-eight (48) scheduled drills, and
 - Active duty for training between 14 and 29 days.
- The team's personnel are executing this study to complete U.S. Army War College requirements and a full course load for a graduate degree.
- This estimate must be completed by April 2023.
- The amount of information on this topic is currently unknown as we explore the future environment
- Due to time and equipment constraints, the team can access mostly open-source information.
- Limited funding is available to support travel and other related expenses.
- Commercial industry members may be less forthcoming with information as their product field is only emerging now, and their ideas are proprietary.

Resources:

- The team will utilize the U.S. Army War College database and resources along with other commercial and educational resources available.
- The team will identify and connect with government, academia, organizational, and private subject matter experts.
- The team will utilize open-source media and published information from academic and professional institutes.
- The team is comprised of Army Active Duty and Reserve officers with diverse backgrounds
- The team will leverage personnel and professional relationships with colleagues

spanning military, government, academic, organizational, and institutional entities.

Administration:

- The final product will be provided in PDF format and is for the use of MG LeBouef and those he so designates.
- The team will conduct the final brief in April 2023. The optimal time for the out-brief is between 24-28 April 2023.
- Team Point of Contact:
 - COL Robert “Bobby” Shadowens, 803-719-0295,
robert.shadowens.mil@armywarcollege.edu
- Alternate Team Point of Contact:
 - LTC Michael Mignano, 803-800-7728,
michael.mignano.mil@armywarcollege.edu
- Team Members:
 - COL John Haas
 - COL Keith Vanyo
 - LTC Robert (Bob) McTighe

Annex B - Friedman Corollaries

Two questions a researcher should ask oneself in order to reassess bias and improve validity to an estimate.

1. Is my estimate within the range of reasonable opinion surround the question?
2. How likely is it that new information will change my estimate?

Source: [Jeffrey A. Friedman](#)

Annex C – Standard Primary Source Trust Scale

Trust Scale and Web Site Evaluation Worksheet (Updated JAN 2023)																	
Piece of Evidence #:			Evidence 1		Evidence 2		Evidence 3		Trust Scale:								
Trust Scale:																	
Criteria	Tips	Value	Input (Y/N)	Pts	Input (Y/N)	Pts	Input (Y/N)	Pts									
Content can be corroborated?	Check some of the site's facts	2							<table border="1"> <tr> <td>High</td> <td>15 - 20</td> </tr> <tr> <td>Moderate</td> <td>11 - 14</td> </tr> <tr> <td>Low</td> <td>6 - 10</td> </tr> <tr> <td>Not Credible</td> <td>0 - 5</td> </tr> </table>	High	15 - 20	Moderate	11 - 14	Low	6 - 10	Not Credible	0 - 5
High	15 - 20																
Moderate	11 - 14																
Low	6 - 10																
Not Credible	0 - 5																
Recommended by subject matter expert?	Doctor, biologist, country expert	2															
Author is reputable?	Google for opinions, ask others	2															
You perceive site as accurate?	Check with other sources; check affiliations	1.5															
Information was reviewed by an editor or peers?	Science journals, newspapers	1.5															
Author is associated with a reputable org?	Google for opinions, ask others.	1.5															
Publisher is reputable?	Google for opinions, ask	1.5															
Authors and sources identified?	Trustworthy sources want to be known	1															
You perceive site as current?	Last update?	1															
Several other Web sites link to this	Sites only link to other sites they	1															
Recommended by a generalist?	Librarian, researcher	1															
Recommended by an independent subject guide?	A travel journal may suggest sites	1															
Domain includes a trademark name?	Trademark owners protect their marks	1															
Site's bias in clear?	Bias is OK if not	1															
Site has professional look?	It should look like someone cares	1															
Score		20		0		0		0									
Trust Scale																	

19 Dec 2001: The criteria and weighted values are based on a survey input from 66 analysts. For details see: <http://daxnorman.googlepages.com/analysis>. Edited for simplicity by Kristan J. Wheaton, OCT 2013


3 Feb 2012: Excel Spreadsheet which adds auto-sum was produced by Bill Welch, Deputy Director, Center for Intelligence Research Analysis and Training, Mercyhurst College.

26 Jan 2013: Trust Scale and Web Site Evaluation Worksheet is in the PUBLIC DOMAIN.

11 JAN 2023: Conditional formatting and auto summation updates.

Annex D – Words of Estimated Probability

Kesselman List of Estimative Words

Certainty 100%		
Almost Certain	86 – 99%	 Likelihood
Highly Likely	71 – 85%	
Likely	56 – 70%	
Chances a Little Better (or Less)	46 – 55%	
Unlikely	31 – 45%	
Highly Unlikely	16 – 30%	
Remote	01 – 15%	
Impossibility 0%		

Annex E – Mind Map

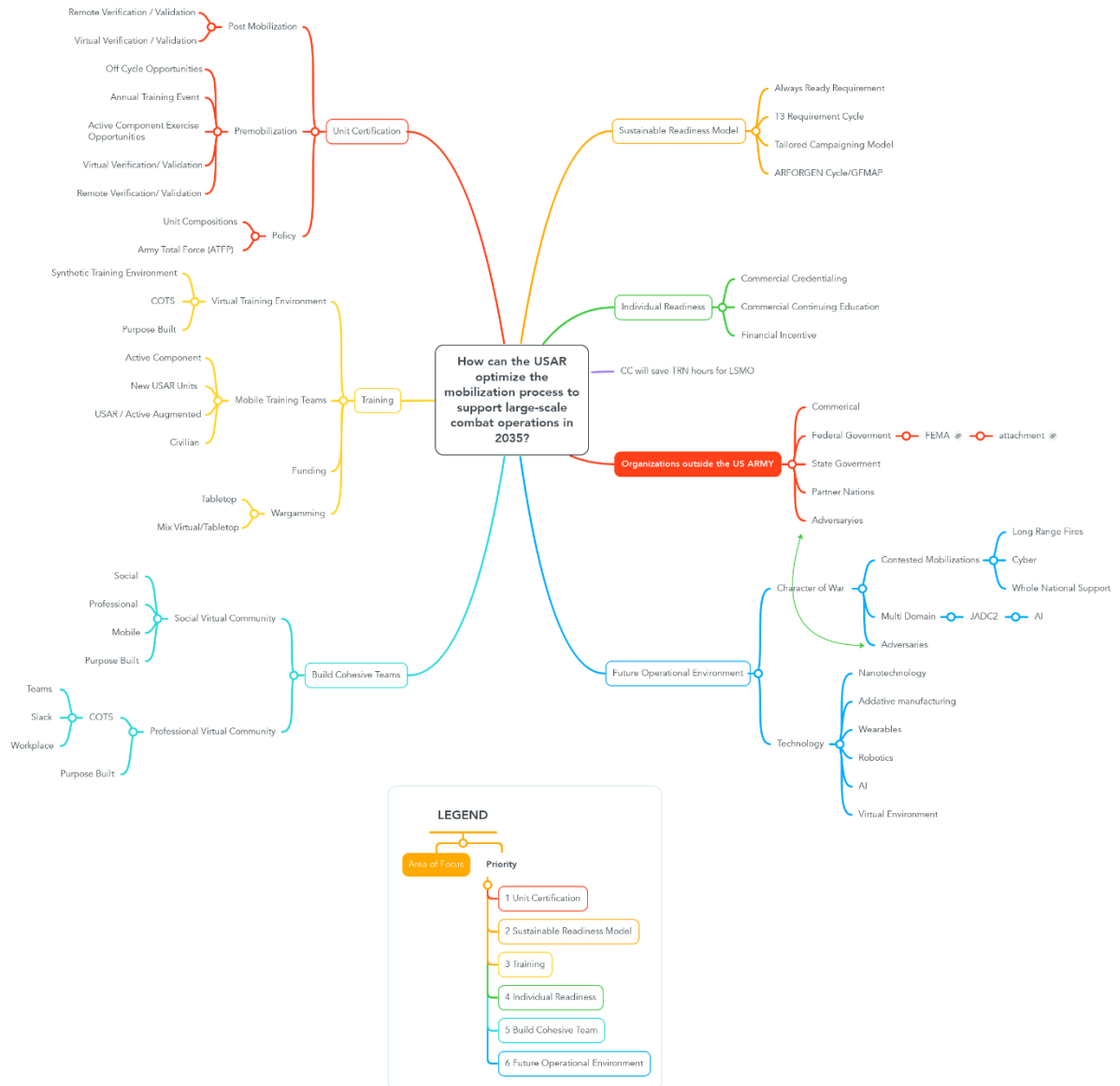


Figure 41: Mind Map

Annex F - Expert Interview Notes

META Interview

Date: 13 March 2023

Location: MS Teams

Attendees:

META:

1. Bridgette Arnold (Law Enforcement Outreach Team Manager)
2. Cody Ankeny (Law Enforcement Outreach Team Member)

Decision Point 2035:

1. COL Bobby Shadowens
2. LTC Michael Mignano
3. COL John Haas
4. COL Keith Vanyo
5. LTC Robert (Bob) McTighe

Quick introductions: Decisive Point 2035 (DP2035) team members introduced themselves. Of note, both Ms. Arnold and Mr. Ankeny have prior military experience. Ms. Arnold is an Air War College graduate.

DP2035 team members briefly described the Army War College Futures program, the Terms of Reference primary question, and our initial hypothesis that META was working on technology that would help optimize synthetic training and, ultimately, large-scale mobilizations.

Question 1: How does META view the future of synthetic training?

A: Oculus II has unique synthetic training attributes already in use today. As an example, the META team described how police forces are using Oculus II for active shooter training and other normally resource-intensive training events. Of note, what normally requires the closing of a facility, role players, rounds, and extensive time can now be done with Augmented or Virtual Reality within the Metaverse. The +2 headset will “transport you to another place.”

Follow-up question: DP2035 team member described some of the variables, units, and friction associated with a Combined Arms Wet Gap Crossing, then asked, Will future technology like the +2 headset be able to replicate a river crossing?

A: Yes, it will make it representative of a real-world environment. A team of Soldiers could gather in a hangar or something, and execute an augmented reality crossing, as if they were in the environment, using the specific equipment they would normally use in combat.

Question 2: Cody, you mentioned the Metaverse, can you briefly explain what that is, and what the future of the Metaverse looks like?

A: If you ask ten people at Meta what the Metaverse is, you'll get ten different answers. That is indicative of it still being in its relative infant stages. The Metaverse is being rolled out in stages, with technology dynamically impacting future stages. The next iteration of the Metaverse will facilitate better interaction, communication, and collaboration.

Question 3: What is the next state of digital communication?

A: The Metaverse will be an interoperable and interconnected space. It will provide one space to move in between platforms. This is what separates the Metaverse from normal Virtual Reality. This is the most important piece as it applies to future synthetic training.

Question 4: Does the Metaverse need to be a shared network?

A: No, a closed network can be built (or replicated). Customers have asked, but it's only conceptual right now. Meta hasn't operationalized this yet, but they see that the early adopters will likely be gamers. It might be something that is created small for a tabletop game (like dungeons and dragons) where people stand around a table and look and collaborate on things in a virtual world. A similar concept would be used for military use.

Question 5: Are Meta and other companies collaborating to build/improve haptic feedback to replicate physical touch? We ask because the military must physically do a lot of tasks with their hands (individual and collective training tasks) to really get the realism.

A: Yes, Meta and other companies are working on developing better haptics; things like a wristband, gloves, etc., that simulate real touch and other senses.

Question 6: If a Soldier was training on their own on specific individual tasks in the Metaverse, would an invisible (or visible) observer be able to grade and certify certain aspects of the training? For example, if a Soldier were executing medical tasks and emplacing a tourniquet in VR, would an observer be able to inspect and test the tightness and effectiveness?

A: The observer piece is possible, but now, due to the limited capabilities to replicate haptics, it is very rigid. When you pick up an "item" in VR, it always works perfectly. Replicating friction and dexterous tasks will continue to evolve. For example, when hand tracking improves, someone can receive feedback.

Additional Notes:

- Meta Team members were excited that the Army is looking at 2035. The technology they are working on takes that long to come to full fruition. They say most of their customers and stakeholders are normally interested in simply the next model.
- Equipment that replicates haptics is bulky and oftentimes un-intuitive, future models will be more visually appealing, intuitive, and more representative of real life.
- Note: DP2035 should engage a gaming company for more on haptics.

PEO-STRI (Synthetic Training Environment) Interview

Date: 04 April 2023

Location: MS Teams

Attendees:

PEO-STRI:

1. LTC Sheila Howell
2. Mr. Brian Comer

Decision Point 2035:

1. COL Bobby Shadowens
2. LTC Michael Mignano
3. COL John Haas
4. COL Keith Vanyo
5. LTC Robert (Bob) McTighe

Following brief introductions, the DP2035 team members briefly described the Army War College Futures Program and the Terms of Reference primary question. We also stated that our initial hypothesis was that PEO-STRI was working on technology that would help optimize synthetic training and, ultimately, large-scale mobilizations.

Question 1: How do you view the future of synthetic training in 2035?

A: PEO-STRI is working on synthetic training solutions today that enable warfighters to train individually and collectively in a distributed environment. As it stands now, the technology associated with the Synthetic Training Environment (STE) program allows organizations to execute tasks that are usually associated with the crawl and walk phases of training. In the future, it is in the realm of possibility that the technology could advance so much that it could substitute live training and serve as a certifying event. This change would require shifts in culture.

Follow up: When will the synthetic training environment fully replicate in-person training?

A: Giving a specific date when STE could replace in-person is impossible. Currently, STE is better suited for specific units, and systems are great for replicating platform-specific crew drills. Although replicating in-person training for all Army tasks is in the realm of possibility, there are still some areas where it is lacking. As one example, functions like maintenance training have not been addressed. To date, solutions have been more focused at the collective and battle drill level, but an extension into individual tasks is possible. What is more likely is that there will be around 60-70 percent of the required tasks available

virtually or through Massive Open Online Course (MOOC) solutions, but there will still be a need to come together for in-person training on certain things.

Question 2: What cultural barriers have you encountered?

A: STE technology is in the fledgling stage, but everything we've discussed is feasible in 2035. However, because of the radical change, PEO-STRI maneuvers through cultural barriers daily. For example, right now, very few commanders would bless off on executing virtual training instead of live in-person training. Even with infantry squads, though they continuously use these systems for drill sets and reps, they rely on them increasingly for TTP and SOP building. As another example, virtual trainers usually go to TAS-C for use. The Squad Immersive Virtual Trainer, though, is meant to be an MTOE item. Units balked at this concept because they "wouldn't take a trainer to deploy." They accepted and encouraged the MTOE change when they realized they could use this equipment for rehearsals and more complex training. Familiarity breeds system acceptance, and change takes time.

Question 3: What are the technological limitations of the technical solutions your team is working on?

A: There are quite a few. The biggest challenge is that the mission scope is in flux. The Army doesn't appreciate the time and money associated with these systems and will often search for quick wins instead of long-term solutions. The shortcoming of the virtual trainer is that it is for only indoor use. However, as units become increasingly familiar with the technology, they want to use it with real-world training to provide a more adjusted reality instead of a virtual reality training environment. This equipment is being overhauled for outdoor use now. Another example is one of the commercial partners, one world terrain struggles to replicate finite technical, environmental details of specific geographic areas.

Follow up: Can the STE project adapt to emerging commercial products, and are the systems developing simultaneously?

A: There are a lot of emerging capabilities out there. The world is moving fast, and this technology development is a modular open system, but the technology competition is driving rapid change for the better.

Question 4: Is PEO-STRI collaborating to build/improve haptic feedback to replicate physical touch? We ask because the military must physically do a lot of tasks with their hands (individual and collective training tasks) to get the full realism effect.

A: Yes, the IVAS heads-up display provides augmented reality. Also, from a medical training and capability standpoint, VR and advanced haptics are used to provide telemedicine solutions.

Question 5: Can training certification or validation be completed virtually within the STE?

A: For example, if a unit or individual completed tasks X, Y, and Z using the virtual trainer, it can populate some sort of tracking mechanism regarding task completion status and level of effectiveness. The capability exists now for OC-T to assess training in the synthetic environment in the same manner they do in live training. In 15-20 years, executing and assessing training in the virtual world may just be second nature.

Question 6: Will the USAR be allocated IVAS?

A: Yes. They aren't doing much now, but the overall fielding plan is for SiVT and IVAS to go to the total force.

Follow up: Does the future network support the bandwidth requirements of the STE?

A: This is an ongoing discussion. Overall, the STE program has a high bandwidth requirement. Specific systems are not specifically bandwidth hogs, but the bandwidth requirements are significant as a whole. We are looking at how our systems work ICW the 5G network and looking to cloud computing to ease some of the bandwidth requirements.

42 Education Games Coaching and Design (Gamification) interview notes

Date: 14 April 2023

Location: Zoom

Attendees:

Ray Kimball, EdD, Founder and CEO, 42 Educational Games Coaching and Design

Dr. Kris Wheaton, Futures lead

Decisive Point 2035:

1. COL Bobby Shadowens
2. LTC Michael Mignano
3. COL John Haas
4. COL Keith Vanyo
5. LTC Robert (Bob) McTighe

Following brief introductions, the DP2035 team members briefly described the Army War College Futures program and the Terms of Reference primary question. The below notes are paraphrased and not direct transcription.

Before going into the questions, Mr. Kimble clarified some of his biases regarding gamification and games-based learning. Games-based learning forces people to adopt different preferences, but gamification adds layers to existing systems. He is more of a proponent of games-based systems for education than gamification. Though, Mr. Kimble believes that gamification has a place in training, specifically in the context of our Decisive Point 2035 synthetic training approach.

Question 1: How do you view the future of gamified systems?

A: Gamification and gamified systems will continue to grow and evolve, specifically as learning management systems. Mechanisms such as leaderboards and badges will continue to grow and spread out into other systems. Additionally, leaderboard statuses may become more publicly available, affecting things like social standing and evaluations.

One of the challenges with gamification layers is that it often trivializes the overarching intent of the learning or training. A lot of literature argues that gamification is inappropriate for an academic setting, and gamification can encourage behavior not aligned with organizational values.

Question 2: How will the gaming industry evolve in the next ten years?

A: Generative AI, image AI, and video AI is the aspect of technology that will influence the gaming industry in the next ten years and sooner. Although generative AI has shown a propensity to hallucinate (provide non-factual information), it has proven effective at creating things that don't exist. If a Soldier participated in a game-based learning scenario and completed a section or module effectively, generative and video AI would create a new design based on the previous results. Training and scenarios will evolve and build on themselves. As glitches in generative AI are fixed, and more factual information is generated, systems will improve. These improvements are probably closer to five years away than ten. Even today, ChatGPT can play the role of "Dungeon Master" in an interactive online game of Dungeons and Dragons.

Follow up: We tend to build our games so strong that the adversary is a non-representational undefeatable giant. How do we avoid this in future games?

A: In training and education, it's okay to be overmatched; the debrief or after-action review is the most beneficial aspect. However, game designers and AI must represent a true adversary capability.

Follow up (Dr. Wheaton): 15 years ago, people discussed the theory of fun when designing a game. Due to the varying definition of fun, most game designers avoided including "fun" in their architecture.

A: This is similar to today's approach to learning. Educators used to think that if someone is a visual learner, this is the only way to grasp new information, which is not true effectively. People learn or have fun in many different ways. Just because you prefer a particular form of learning or pleasure doesn't mean the other methods are invalid.

Follow up (Dr. Wheaton): Regarding transference, how do skills learn in games-based education apply to the real world?

A: The current theory is that game-based learning helps immensely and transfers well. Games-based education also helps with reflection.

Question 3: Do you see an opportunity for the Army to incorporate gamification techniques into synthetic (XR) training?

A: Gamification techniques could be helpful in individual training and entry-level education, especially when looked at through the lens of the current Army Warrior Tasks and Battle drills. These are required basic skills that Soldiers could complete in a virtual setting, and once completed, a badge or leaderboard could communicate training

completion and proficiency.

Follow up: What is the application for game-based learning?

A: Game-based learning is primarily helpful in the run-up leading to the 30-day mobilization window. I would love to see some game-based education incorporated into steady-state training.

The Dietz Foundation recently released a game called Littoral Commander. This is, in essence, a virtual board game that plays out a variety of scenarios against a thinking adversary.

Question 4: While dealing with organizations that generally don't use games for education, what cultural barriers have you experienced when implementing gamified solutions?

A: If culture eats strategy for breakfast, then culture eats technology for lunch. You can have all the leaderboards and badges in the world, but what the organization's culture does with this is the real question. If the leaderboard shows that someone completed all the required tasks to standard the fastest, does this affect their rank, pay, or standing inside the organization, or is this just a check-the-block requirement?

Additional Comments:

Dr. Wheaton asked: Based on your understanding of the trends, what does the future combined, live-synthetic- game-based training path look like?

A: Imagine a new 2LT in the National Guard. He is a PL that just graduated from his commissioning source. He joins the unit for the first time. This first contact is the weekend training, and that does not change. Bringing someone into the culture of a team is always best done live. On that first drill weekend, he undergoes a variety of tasks; maybe some are game-based, while some are still old-fashioned in-person lecture type. He undergoes a mix of experiences. Over the next 12 months, this PL does a series of online/ interactive individual games ranging from building combat skills to building empathy and judgment. Then this PL's organization gets alerted, and the specific XR-based training begins. It includes models, branches, and sequels particular to the targeted environment. This approach yields a PL who is confident in himself, his superiors, and his subordinates; he is ready to deploy.

Annex G – PowerPoint Slides



Research Questions

How can the United States Army Reserve optimize the mobilization process to support large-scale combat operations in 2035?

Describe mobilization environment in 2035.


How does enterprise optimize pre-mobilization readiness?

What is required to maintain/build cohesive teams?

What is required to leverage individual skills?

What is required to optimize mobilization certification?



A photograph of a person's hands typing on a laptop keyboard. The image is overlaid with a semi-transparent dark grey box containing text. The background image has a light, warm-toned overlay.

United States Army Reserve is highly likely to optimize the mobilization process to support large-scale combat operations in 2035 by leveraging technological advances and implementing decentralized mobilization.

The United States homeland can no longer be considered a sanctuary



Characterization of The Future Mobilization Environment

Technology
Geopolitical Shifts
Emerging Threats



Artificial Intelligence

Autonomous systems

Advanced missile technology

Cyber and Space Warfare



A resilient homeland will enable a high level of readiness to rapidly deploy forces to any region of the world



XR and Talent Management Artificial Intelligence will likely enable the USAR to build and maintain cohesive teams



XR Technology Is Being Rapidly Advanced And Promulgated

Commercial retail
Industrial training
Gaming
Education



Talent Management Enhanced AI

Candidate screening
Individual assessment
Team tailoring
Predictive impact assessments
Training requirement identification



Synthetic Training Environment of Today

PEO- STRI

Integrated Visual Augmentation System

Reconfigurable Virtual Collective Trainer

One World Terrain



Synthetic Training Environment

Real-life replication of individual and collective training

13-month to one-month mobilization

Efficient, cost-effective

Necessitated by contested environment

Mobilization Training Approach (Notional/ 2035)



Extended Reality

Massive Open
Online Courses
(MOOC)



Artificial
Intelligence

Live Training



Synthetic Training Environment

- At-home training
- Incentivization through gamification
- Enhanced MOOCs
- Home station mobilization
- Mobile STE training team
- Remaining in-person (live) training

Mobilization Training Approach (Notional/ 2035)



Decentralized Soldier Readiness Process

- Revolutionize USAR's SRP
- Integration of AI, administration and telemedicine
- Streamlined soldier readiness

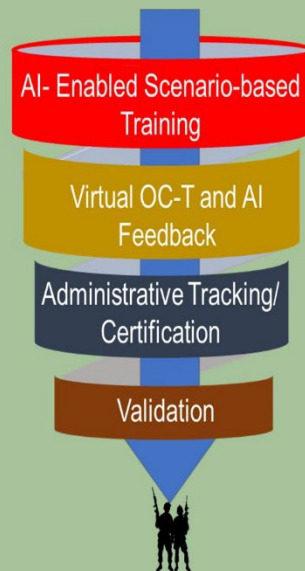




AI Enhanced Logistics

Overburdened Transportation Enterprise
 Military primacy across transportation nodes
 Autonomous trucks, trains, planes, ships
 Decentralized vs. centralized shipping points
 Reduces targeting risk
 STE facilitates increased pre-positioning IAW
 ReARMM

Certification and Validation



Virtual Trainer

Tailored individual training
Streamlined
Feedback in real-time
Customizable



The Main Obstacle: A Cultural Shift

Resistance to remote validation
Resistance to reduced live training
Low trust in AI

Remote Validation

Current model is 8 steps and is 30-years-old

Remote validation will eliminate Mobilizations Stations

Pre-Mobilization training

Alert

Home Station

Mobilization Station

Readiness Improvement

Port of Debarkation

Theater

RSOI in Theater



Live Training

FM 7-0 established live training as integral to mobilization

XR recognized as steppingstone

Reduced or eliminate

Leaders consider live training essential



Low Trust in AI

Lack of knowledge
Lack of familiarity
Concerns of algorithm bias
Unintended outcomes



**DECISIVE
POINT
2035**

