

Mad Scientist: Disruption and the Future Operational Environment Final Conference Report 25 July 2019

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Introduction

The Army in the future will need to conduct Multi-Domain Operations (MDO) in a dynamic Future Operational Environment characterized by rapid disruption from external influences, including commercial entities, public and private S&T and R&D, and political-military developments and economics. **To adapt rapidly and restore order to this chaotic environment, the Army must convert potential challenges into opportunities through foresight, assumption of risk, and initiative.** Foresight, through technology forecasting, early experimentation, horizon scanning, and weak signals analysis, will allow the Army to get ahead of the cost and innovation curves, design forces for quick integration of new technology, and develop new support infrastructure that will enable forces to carryout MDO missions. Taking the initiative to explore relatively unfamiliar military domains such as space, as well as forging new connectivity between the Army modernization enterprise and industry and academia will allow the Army to execute the top-down acquisition approach with a totality of the relevant players. Finally, these elements would bring about an additional assumption of risk that the Army would need to embrace to mitigate the effects of disruption and ensure success in the FOE. The Mad Scientist Disruption and the Future Operational Environment conference generated the following key findings in support of this new approach:

- There currently is a fierce global competition to develop Artificial Intelligence (AI) and robotics capabilities. **The actor that wins the race for supremacy in these areas has a chance to gain strategic overmatch over its adversaries akin to the Army's ability to "own the night" in the 1980s and 1990s.**
- The complexity, democratization, and rapid advancement of technology will force structural and process changes in innovation and modernization. To adjust, the Army must make **strategic investments through forecasting, rapid scalability, and shift focus from exquisite platforms to cost-informed or disposable effects.**
- The space domain, is becoming increasingly congested, which presents challenges for the Army in a domain that is not well-defined, surveilled, or understood. **There is opportunity to take the lead in mapping the orbital landscape through international cooperation, crowdsourcing, and AI.**
- Robotic advancements are already being tested by industry and academia in harsh environments such as space and disaster. **The Army can leverage this external research and development (R&D) capital and time expenditures to propel its own initiatives** that will add capabilities in an austere battlefield characterized by degraded communications, challenging terrain, and difficult atmospheric conditions.
- The advent of disruptive technologies brings with it a multitude of ethical and moral dilemmas that will outpace current laws, doctrine, regulations, and policy. **The Army will be challenged with defining rules of engagement, ethical boundaries, and research, development, and operating policies.**

In a Future Operational Environment (FOE) constantly shifting between competition and conflict, there is little space to patiently acquire and integrate increasingly rapid technological advances. The future cannot be described by linear projection. While the Army builds future forces based on the assessed FOE, it also has the opportunity to anticipate the impact of trends and developments in its assessments, establish greater dynamic readiness, and disrupt itself before it is disrupted.

To explore a range of possible futures, potential disruptors, and new battlefield frontiers, the United States Army Training and Doctrine Command (TRADOC) and the Army Futures Command (AFC) on 24 – 25 April 2019 co-hosted the “*Mad Scientist: Disruption and the Future Operational Environment Conference*” with the Cockrell School of Engineering at the University of Texas at Austin. The conference explored robotics, artificial intelligence (AI), space, drones, and science fiction, as well as the ethical, moral, and legal considerations in these fields. Conference attendees included representatives from private industry, academia, and a host of government and military organizations, including the Army Science and Technology (S&T) enterprise, Defense Advanced Research Projects Agency (DARPA), NASA, NATO, FBI, foreign military representatives, and several national laboratories. Keynote speakers discussed a number of topics ranging from AI to space traffic management to collaborative dexterous robots, challenging participants to explore the known, the unknown, and the unbelievable. Additionally, several hundred other global participants viewed the conference via livestream on the Internet.

Own the Night

“When you’re bogged down in war it will naturally limit your ability to think about the future.”

In the late 1970s, following the end of the Vietnam War, U.S. operational planners started to ponder how to “Fight Outnumbered and Win.” Toward this end, the Army vowed to “Own the Night” – to leverage technology and training to successfully conduct offensive night operations with a level of familiarity and comfort commensurate with daytime operations. Further, nighttime defensive capabilities of other nations were 10 percent of what they would be during the day.¹

Today, the Army is facing a similar “Own the Night” moment. To ensure future battlefield overmatch, the Army has a unique opportunity to seize the initiative in an openly competitive technological space — AI and robotics — rather than succumb to forced modernization from a point of strategic disadvantage. There are four conditions underpinning this new “Own the Night” imperative:

1. The proliferation of miniaturized guided munitions and democratization of other military technologies will make the battlefield increasingly lethal for humans, hastening the development of unmanned autonomous systems to take on the most deadly combat tasks – dull, dirty, and dangerous.
2. Humans are becoming more expensive to recruit, train, and retain, hastening the move to unmanned and robotic systems to replace them, especially for ground forces.
3. Land warfare involves fighting amongst the people, requiring the most demanding performance for autonomous systems in terms of ethics, Law of Armed Conflict – distinction and proportionality –, and trust.
4. Future combat operations may occur in dense urban settings, where combat operations will rely heavily on human-machine combat teams. The pervasive presence of the Internet of Things (IoT) provides a bevy of information to both the robotic agents as well as their human counterparts.²

Gaps in the global competition for development of AI and robotics are quickly narrowing. Strategic competitors recognize the importance of AI, particularly to match and overtake the superior military capabilities that the United States and its allies have held for the past several decades. Highlighting this importance, Russian President Vladimir Putin in 2017 stated that “whoever becomes the leader in this sphere will

¹ Adam K. Raymond “‘We Own the Night’: The Rise And Fall Of The US Military’s Night-Vision Dominance,” Task & Purpose <https://taskandpurpose.com/night-rise-fall-us-militarys-night-vision-dominance>

² Work, Robert O., Mad Scientist Conference: Disruption and the Future Operational Environment, University of Texas at Austin, 24 April 2019.

become the ruler of the world.”³ Russian military forces have already combat tested unmanned combat ground vehicles in Syria, applying lessons learned to future iterations of unmanned and autonomous combat systems.⁴ Within the past decade, China has invested heavily in government-funded AI initiatives. Military thinkers within the Chinese People’s Liberation Army (PLA) embrace AI’s prospects as “leapfrog technology” that would allow China to skip technological development stages and rapidly overmatch U.S. capabilities.⁵

U.S. success in this competition is dependent upon focus (R&D dollars and manpower concentration), adaptability (organizational flexibility and external partnerships), and innovation (creativity, integration, and cultural awareness). While the U.S. pursues its next iteration of “Owning the Night”, it will need a more defined strategy that focuses beyond developing and purchasing new generations of technology. Emerging technologies such as AI and robotics will require a continued investment by the Army and Department of Defense with clear strategic guidance for all stakeholders. As with the first “Own the Night” moment, the Army will also need to include development of new tactics, techniques, and procedures (TTPs) and intense, sustained training.

The Army can gain multiple advantages by developing unmanned, optionally tele-operated systems rather than optionally manned systems, such as:

- Moving to the right side of the cost curve by avoiding investment in expensive armor and other human protection features.
- Achieving greater performance – speed, agility, maneuverability – and energy efficiency without humans on board.
- Creating greater warfighter effectiveness through increased man-machine teaming.

Robotic and unmanned systems are prevalent throughout the six Army modernization priorities – Long range precision fires, next generation combat vehicle, Soldier lethality, future vertical lift, Army network, and air and missile defense.⁶

Integration of unmanned robotic systems into all of these priorities is an opportunity for the Army to “Own the Night” and gain overmatch in Multi-Domain Operations (MDO).

³ James Vincent, “Putin Says the Nation that Leads in AI ‘Will be the Ruler of the World,’” *The Verge* <https://www.theverge.com/2017/9/4/16251226/russia-ai-putin-rule-the-world>

⁴ Kendrick Foster, “The Modern Pen and the AI Sword,” *Harvard Politics Review* <https://harvardpolitics.com/united-states/pen-ai-sword/>

⁵ Gregory C. Allen “Understanding China’s AI Strategy,” *Center for a New American Security* <https://www.cnas.org/publications/reports/understanding-chinas-ai-strategy>

⁶ “Modernization Priorities for the United States Army” 3 Oct. 2017. <https://admin.govexec.com/media/untitled.pdf>

Technology Forecasting and Innovation Paradigm Shift

Technological complexity and proliferation of advanced systems will affect all aspects of the Future Force, from the combat arms branches to critical enablers such as logistics and intelligence. **The Army could see considerable gains in lethality, capability, and capacity from changes and reforms to technology forecasting and platform acquisition.** As the FOE evolves, the Army has the opportunity to develop itself in ways that achieve and maintain primacy and overmatch.

The U.S. has enjoyed technological superiority in most areas of warfare in the post-Cold War era. Capabilities related to precision weapons systems and broad connectivity have created an overreliance on developing “exquisite” systems in Western militaries, while conversely, commanders often are risk-averse to committing expensive pieces of equipment to the field.⁷ Additionally, the global democratization of technology that allows traditionally weaker actors to employ high-threat capabilities presents challenges to exquisite and expensive platforms and capabilities that rely on long-range acquisition cycles.

There are a number of ways the Army can achieve agility, fiscal savings, and adaptability in modernization. Three that were discussed at the conference were:

- 1) Shifting focus from exquisite and expensive platforms to cost-informed and potentially disposable effects.⁸
- 2) Forecasting technology trends to promote successful S&T investment.⁹
- 3) Emphasizing rapid and selective scalability based on unit capability requirements vice conventional broad and generalized materiel provisioning.

State and non-state actors such as Ukrainian military forces in Donbas and Huthi rebels in Yemen have shown a remarkable ability to rapidly develop and field semi-autonomous and precision-guided systems, often leveraging commercial off-the-shelf (COTS) capabilities to great effect.^{10,11} The Army has taken important steps to become similarly agile and innovative in force development by standing up eight Cross-Functional Teams (CFTs) to generate requirements for the Army’s modernization priorities. The Army can leverage these teams to quickly adopt and experiment with low-cost and disposable technology, helping to push experimental systems to the

⁷ Paul Barnes and Ali Stickings, “The Death of Precision in Warfare?” *War on the Rocks*, <https://warontherocks.com/2018/11/the-death-of-precision-in-warfare/>

⁸ Work, Robert O., Mad Scientist Conference: Disruption and the Future Operational Environment, University of Texas at Austin, 24 April 2019.

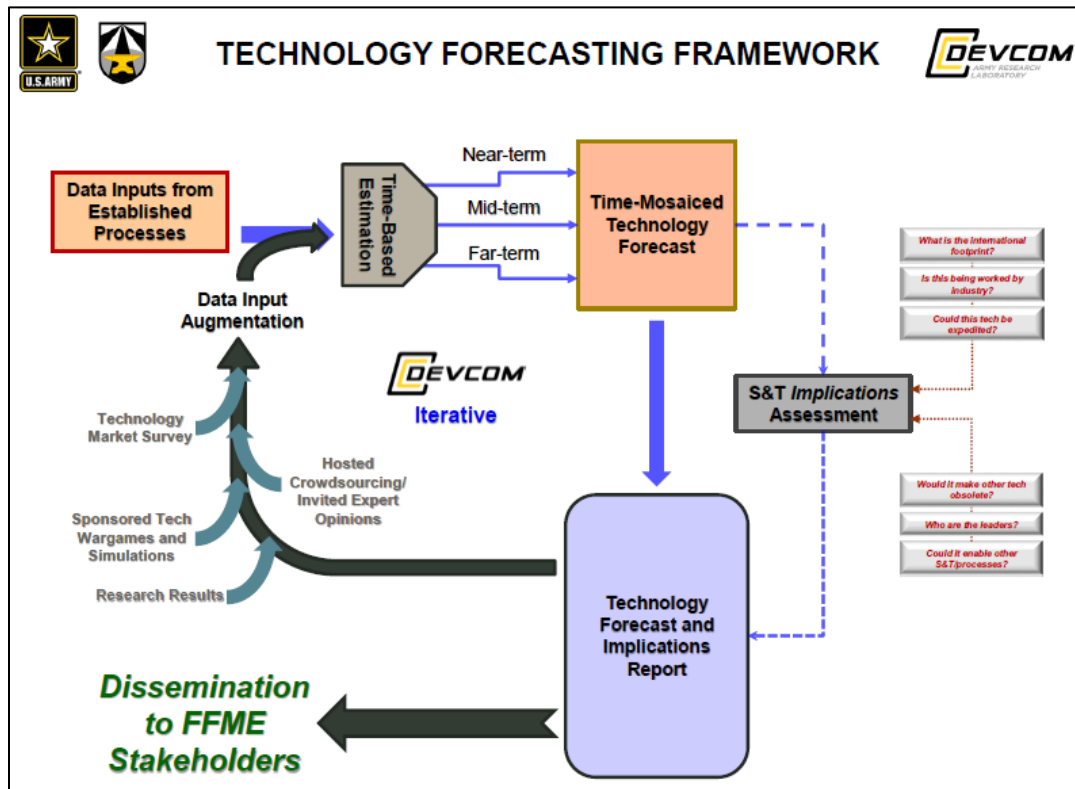
⁹ Alexander, Troy, Mad Scientist Conference: Disruption and the Future Operational Environment, University of Texas at Austin, 25 April 2019.

¹⁰ Roblin, Sebastien, “Ukraine is Developing Remote Controlled Killer Robots to Wage War in Eastern Ukraine,” *The National Interest*, 13 Jan. 2019. <https://nationalinterest.org/blog/buzz/ukraine-developing-remote-control-killer-robots-wage-war-eastern-ukraine-41337>

¹¹ Liptak, Andrew, “Drones are Giving Houthi Rebels an Edge in the Ongoing War in Yemen,” *The Verge*, 3 May 2019. <https://www.theverge.com/2019/5/3/18527205/drones-explosives-yemen-war-houthi-rebels-edge-violence-borders>

combat units quickly and effectively.¹² Capturing the successes and failures from this quick fielding would then inform future acquisition priorities.

Technology forecasting is a robust, scientifically-based approach, dedicated to providing forecasts of probable technological developments from the near-term to the deep future, with a focus on Army and national security implications. It is crucial for efficient S&T investments that may not follow linear projections and for changing the modernization paradigm. As depicted in the image below, technology forecasting consists of more than singular prognosticating.



Technology forecasting is accomplished through a variety of activities – crowdsourcing, trend analysis, wargaming, theoretical limit analysis, and intelligence collection and analysis – that paint an all-encompassing picture of the future technology landscape. It is a combined effort by multiple entities within the Army – S&T enterprise, Army Futures Command, intelligence activities – as well as comparable external entities within academia and industry. Technology forecasting enables the Army to leverage a thorough understanding of emerging technologies with their context on the battlefield to more selectively and effectively satisfy unit demand. One of the factors encumbering agile and rapid modernization in the Army is its sheer size. **The combination of technology forecasting with an emphasis on cost-informed or disposable effects potentially changes the paradigm of acquisition from long cycles to rapid and selective scalability increasing unit readiness and capability.**

¹² South, Todd, "Four Takeaways from the 4-star General at Army Futures Command," *Army Times*, 7 May 2019. <https://www.armytimes.com/news/your-army/2019/05/07/four-takeaways-from-the-4-star-general-at-army-futures-command/>

Space

“Everybody wants to launch satellites”

Space has the potential to become the most strategically important domain in the FOE. A maneuver Brigade Combat Team (BCT) today has over 2,500 pieces of equipment dependent on space-based assets for Positioning, Navigation, and Timing (PNT).¹³ This number is only going to expand as emerging technology on Earth demands increased bandwidth, new orbital infrastructure, niche satellite capabilities, and advanced robotics.

Low Earth Orbit is cluttered with hundreds of thousands of objects, such as satellites, debris, and other refuse that can pose a hazard to space operations, and only one percent of these objects are tracked.¹⁴ This complexity is further exacerbated by the fact that there are no universally recognized “space traffic rules” and no standard operating procedures. Additionally, there is a space “gold rush” with companies and countries racing to launch assets into orbit at a blistering pace. The FCC granted over 7,500 satellite licenses to SpaceX alone over the next five years, and the U.S. has the potential to double the number of tracked space objects in that same timeframe.¹⁵ This has the potential to cause episodes of Kessler syndrome – where cascading damage produced by collisions increases debris by orders of magnitude.¹⁶ This excess debris also could be used as cover by an adversary for a hostile act, thereby making attribution difficult.

There are efforts, such as University of Texas-Austin’s tool ASTRIAGraph, to mitigate this problem through crowdsourcing the location of orbital objects. A key benefit of these tools is their ability to analyze all sources of information simultaneously so as to get the maximum mutual information on desired space domain awareness criteria and enable going from data to discovery.¹⁷ One added benefit is that the system layers the analysis of other organizations and governments to reveal gaps, inconsistencies, and data overlaps. This information is of vital importance to avoid collisions, to determine what is debris and what is active, and to properly plan flight paths. **For the military, a collision with a mission-critical asset could disable warfighter capabilities, cause unintentional escalation, or result in loss of life.**

Autonomy will be critical for future space activities because physical human presence in space will be limited. Autonomous robots with human-like mechanical skills performing maintenance and hardware survivability tasks will be vital. For example, NASA’s “Gateway” program relies upon fully autonomous systems to function as it’s

¹³ Houck, Caroline, “The Army’s Space Force Has Doubled in Six Years, and Demand Is Still Going Up,” *DefenseOne*, 23 Aug. 2017. <https://www.defenseone.com/technology/2017/08/armys-space-force-has-doubled-six-years-and-demand-still-going/140467/>

¹⁴ Jah, Moriba, Mad Scientist Conference: Disruption and the Future Operational Environment, University of Texas at Austin, 25 April 2019.

¹⁵ Seemangal, Robin, “Watch SpaceX Launch the First of its Global Internet Satellites,” *Wired*, 18 Feb. 2018. <https://www.wired.com/story/watch-spacex-launch-the-first-of-its-global-internet-satellites/>

¹⁶ “Micrometeoroids and Orbital Debris (MMOD),” NASA, 14 June 2016. https://www.nasa.gov/centers/wstf/site_tour/remote_hypervelocity_test_laboratory/micrometeoroid_and_orbital_debris.html

¹⁷ <https://sites.utexas.edu/moriba/astriagraph/>

devoid of humans for 11 months out of the year. Fixing mechanical and hardware problems on the space station requires a dexterous robot on board that takes direction from a self-diagnosing program thus creating a self-healing system of systems.¹⁸

The military can leverage this technology already developed for austere environments to perform tasks requiring fine motor skills in environments that are inhospitable or too dangerous for human life. As the military continues to expand its mission sets in space, and its assets become more complex systems of systems, it will increasingly rely on autonomous or semi-autonomous robots for maintenance, debris collection, and defense.

¹⁸ Badger, Julia, Mad Scientist Conference: Disruption and the Future Operational Environment, University of Texas at Austin, 25 April 2019.

Exploiting Emerging Technologies to Drive Efficiency

The U.S. Department of Defense (DoD) no longer drives innovation, and war has ceased to be the watershed of emerging innovative technology. This is due to resource and funding constraints and the expense to gain, train, and sustain human Soldiers. These conditions have prompted DoD to explore other methods and areas to maintain a competitive edge over its adversaries. DoD could increase its leveraging of the private sector for technologies to augment and enhance military capabilities. This will enable the Army to focus on areas such as technology assessments and forecasts to understand enemy capabilities and ensure scaled and precise engagement with adversary forces. By leveraging commercial sector technologies and shifting focus to other key areas, the Army will be better prepared to develop the right systems at the right time ensuring overmatch and competitive advantage.

Future warfare will be influenced by advancements in numerous areas including artificial intelligence and nanotechnology. The Army may not lead these technological innovations, but it can still drive innovation with the way it integrates emerging technologies into its formations. Below are potential areas where the Army can leverage the private sector and other governmental organizations to gain efficiencies, improve productivity, and ensure competitive advantage and overmatch:

1. Disaster Robotics: To penetrate the irradiated site of Fukushima, a government-funded consortium of Japanese technology companies and public utilities created mission-specific robotic solutions. These robots could operate in the dark, swim in contaminated water, and access areas of intense radiation lethal to humans.¹⁹ Further, in Paris, firefighters used the Colossus robot to assist them in hard to reach areas at the Notre Dame Cathedral fire. The robot was able to forcibly enter the building, deliver water, provide situational awareness through a variety of onboard sensors, and undertake rescue operations.²⁰
2. Space Exploration: Private space exploration efforts are increasing which will spur technological advancements. Robotic development to explore other planets in deep space will require fuel and battery enhancements as well as advanced sensing and autonomy which all have military utility.
3. Nanotechnology: The medical sciences are leading R&D efforts focused on nanobots. This research can be leveraged for multiple military applications such as creating nanorobotics that can infiltrate enemy areas – even in urban environments – to conduct reconnaissance operations.

¹⁹ Kaiman, Jonathan, "At Japan's Fukushima Nuclear Complex, Robots Aiding the Cleanup After 2011 Disaster," *Los Angeles Times*, 10 Mar. 2016. <https://www.latimes.com/world/asia/la-fg-japan-fukushima-robots-20160310-story.html>

²⁰ Peskos-Yang, Lynne, "Paris Firefighters Used This Remote-Controlled Robot to Extinguish the Notre Dame Blaze," *IEEE Spectrum*, 22 Apr. 2019. <https://spectrum.ieee.org/automan/robotics/industrial-robots/colossus-the-firefighting-robot-that-helped-save-notre-dame>

In a degraded environment, it is crucial to take advantage of advanced robotics which have the capability to access inhospitable areas or pose a high risk of loss of life. More than just purchasing commercial robots or components, the Army can avoid wasting time, money, and talent by capitalizing on previously collected data such as commercial 3D LIDAR mappings for Army modeling and simulations. By leveraging current R&D from the commercial sector and other governmental organizations, the Army can gain efficiencies and focus its efforts on seamlessly integrating these technologies into organizational formations. This will allow execution of multi-domain operations in a complex, contested operational environment ensuring lethality while maintaining Army values and American ways of war.

Ethics, Morals, and Legal Implications

Technological advancement and subsequent employment often outpaces moral, ethical, and legal standards. Governmental and regulatory bodies are then caught between technological progress and the evolution of social thinking. The Disruption and the Future Operational Environment conference uncovered and explored several tension points that the Army may be challenged by in the future.

Space

Space is one of the least explored domains, both militarily and ethically, in which the Army will operate and therefore will encounter many ethical and legal dilemmas. In the course of warfare, if the Army or an adversary intentionally or inadvertently destroys commercial communication infrastructure – GPS satellites – the ramifications to the economy, transportation, and emergency services would be dire and deadly. The Army will be challenged to consider how and where National Defense measures in space affect non-combatants and American civilians on the ground.

International governing bodies may have to consider what responsibility space-faring entities – countries, universities, private companies – will have for mitigating orbital congestion caused by excessive launching and aggressive exploitation space. If the Army is judicious with its own footprint in space, it could reduce accidental collision and unnecessary clutter and congestion. It is extremely expensive to clean up space debris and deconflicting active operations is essential. With each entity acting in their own self-interest, with limited binding law or governance and no enforcement, overuse of space could lead to a “tragedy of the commons” effect.²¹ The Army has the opportunity to more closely align itself with international partners to develop guidelines and protocols for space operations to avoid potential conflicts and to influence and shape future policy. Without this early intervention, the Army may face ethical and moral challenges in the future regarding its addition of orbital objects to an already dangerously cluttered Low Earth Orbit. What will the Army be responsible for in democratized space? Will there be a moral or ethical limit on space launches?

Autonomy in Robotics

Robotics have been pervasive and normalized in military operations in the post-9/11 operational environment. However, the burgeoning field of autonomy in robotics with the potential to supplant humans in time-critical decision-making will bring about significant ethical, moral, and legal challenges that the Army, and larger DoD are currently facing, at a smaller scale. This issue will be exacerbated in the FOE by an increased utilization and reliance on autonomy.

The increasing prevalence of autonomy will raise a number of important questions. At what point is it more ethical to allow a machine to make a decision that may save lives of either combatants or civilians? Where does fault, responsibility, or attribution lie when an autonomous system takes lives? Will defensive autonomous

²¹ Munoz-Patchen, Chelsea, “Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty,” *Chicago Journal of International Law*, Vol. 19, No. 1, Art. 7, 1 Aug. 2018. <https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=1741&context=cjil>

operations – air defense systems, active protection systems – be more ethically acceptable than offensive – airstrikes, fire missions – autonomy? Can machine learning/AI make decisions in line with Army core values?

Deepfakes and AI-Generated Identities, Personas, and Content

A new era of information operations (IO) is emerging due to disruptive technologies such as deepfakes – videos that are constructed to make a person appear to say or do something that they never said or did – and AI generative adversarial networks (GANs) that produce fully original faces, bodies, personas, and robust identities.²² Deepfakes and GANs are alarming to national security experts as they could trigger accidental escalation, undermine trust in authorities, and cause unforeseen havoc. This is amplified by content such as news, sports, and creative writing similarly being generated by AI/ML applications.

This new era of IO has many ethical and moral implications for the Army. In the past, the Army has utilized industrial and early information age IO tools such as leaflets, open-air messaging, and cyber influence mechanisms to shape perceptions around the world. Today and moving forward into the FOE, advances in technology create ethical questions such as: is it ethical or legal to use cyber or digital manipulations against populations of both U.S. allies and strategic competitors? Under what title or authority does the use of deepfakes and AI-generated images fall? How will the Army need to supplement existing policy to include technologies that didn't exist when it was written?

AI in Formations

With the introduction of decision-making AI into combat and supporting units that have never been in previous requirements, the Army will be faced with questions about trust, man-machine relationships, and transparency. Does AI in cyber require the same moral benchmark as lethal decision-making? Does transparency equal ethical AI? What allowance for error in AI is acceptable compared to humans? Where does the Army allow AI to make decisions – only non-combat or non-lethal?

Commanders, stakeholders, and decision-makers will need to gain a level of comfort and trust with AI entities exemplifying a true man-machine relationship. The full integration of AI into training and combat exercises provides an opportunity to build trust early in the process before decision-making becomes critical and life-threatening. AI often includes unintentional or implicit bias in its programming. Is bias-free AI possible? How can bias be checked within the programming? How can bias be managed once it is discovered and how much will be allowed? Finally, does the bias-checking software contain bias? Bias can also be used in a positive way. Through machine learning – using data from previous exercises, missions, doctrine, and law of armed conflict – the Army could inculcate core values, ethos, and historically successful decision-making into AI.

²² Robitzski, Dan, "Amazing AI Generates Entire Bodies of People Who Don't Exist," *Futurism.com*, 30 Apr. 2019. <https://futurism.com/ai-generates-entire-bodies-people-dont-exist>

If existential threats to the United States increase, so does pressure to use artificial and autonomous systems to gain or maintain overmatch and domain superiority. As the Army explores shifting additional authority to AI and autonomous systems, how will it address the second and third order ethical and legal ramifications? How does the Army rectify its traditional values and ethical norms with disruptive technology that rapidly evolves?

Conclusion

Predicting disruption, and its effects, is akin to predicting a Black Swan event. The Army can't know when it will occur or how significant it will be, but it can take steps to prepare for its arrival and mitigate its effects. Disruption will continue to redefine our perception of the FOE as the gap between competition and conflict narrows. The Army will become more challenged to acquire and integrate technology at a pace commensurate with rapid advances. The insights gained from subject matter experts at the Disruption and the Future Operational Environment conference will help the Army meet the challenges of technological, societal, economic, environmental, and political disruption that impact the FOE.

Per TRADOC Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028*, "Successful competition requires Army forces actively engaging across domains (including space and cyberspace)" and space-based reconnaissance is one of the most important ISR capabilities retained at the national and military district levels²³. A major tenet of MDO is the ability to maneuver across strategic distances which requires reliable communications and GPS capability – both highly dependent on space assets. The congested and unregulated nature of space is a glaring potential vulnerability to Multi-Domain Operations that the Army can help mitigate through the creation of "space-traffic rules" in coordination with other space-faring countries. Formalizing a process for launching satellites will help the Army to identify and track space assets to avoid collision and determine nefarious intent. Unencumbered access to space will help ensure consistent communication and GPS, thus allowing Commanders to execute Multi-Domain Operations.

Success in modernization is partly dependent upon the Army's ability to take initiative in the emerging realm of combat robotics, integrate technology forecasting into its acquisition processes, and forge new partnerships with academia and industry. Robotics cross-cuts many of the Army CFTs like Soldier lethality and next generation combat vehicles. Since the CFTs have the authority to stimulate action, break down barriers, and make necessary connections to move ideas forward, using them to make robotics an Army priority in capabilities development may be the most effective and quickest way to "own the night." This would give Commanders faster access to robotic systems that could take Soldiers out of harm's way or accomplish missions that humans can't.

AFC's Top-Down Futures Development Process aims to deliver quality solutions to Soldiers to ensure future mission success. This process is already infused into current development processes, but could be further enabled by accurate technology forecasting that begins with consideration of known threats as a foundation to develop S&T estimates. These S&T estimates would influence and shape the depiction of the Future OE based on the discovery of new technology trends and guide Army capability and concept development. Technology forecasting should underpin OE analysis and would provide analysts with a framework rooted in science with which to describe the future. An approach combining these groups will be key to maximizing the Army's

²³ TP525-3-1

intellectual capital and provide decision makers and Senior Leaders with the most accurate picture of the FOE.

Disruption is painful, particularly for a massive organization with necessary regulations and procedures, but it is not a death knell. The lessons learned from the “*Mad Scientist: Disruption and the Future Operational Environment*” conference provide a pathway for the Army to navigate and control the effects of disruption to successfully execute Multi-Domain Operations, support AFC’s Top-Down Futures Development process, and consider the moral, legal and ethical effects of new technology early in the development process.

0800-0840	REGISTRATION / NETWORKING
0840-0850	<u>ADMIN REMARKS</u> Mr. Lee Grubbs, Director, Army Mad Scientist Initiative
0850-0905	<u>WELCOME REMARKS</u> Lieutenant General James M. Richardson, Deputy Commanding General, U.S. Army Futures Command
0905-0920	<u>WELCOME REMARKS</u> Dean Sharon Wood, University of Texas at Austin, Cockrell School of Engineering
0920-1005	<u>KEYNOTE SPEAKER</u> Dr. James Canton, Global Futurist, Institute for Global Futures
1005-1030	NETWORKING BREAK
	THEME: ROBOTICS
1030-1115	<u>AI and Future Warfare: The Rise of the Robots (and Army Futures Command)</u> Mr. Robert O. Work, Senior Counselor for Defense and Distinguished Senior Fellow for Defense and National Security, Center for a New American Security (CNAS) and Owner, TeamWork, LLC
1115-1200	<u>System of System-Enhanced Small Units (SESU)</u> Dr. Paul Zablocky, Program Manager, Strategic Technology Office (STO), Defense Advanced Research Projects Agency (DARPA)
1200-1330	NETWORKING LUNCH SENIOR LEADER LUNCH (Invitation only) AND OPTIONAL TOURS
1330-1415	<u>The Robocup Challenge (2050) and Human in the Loop Machine Learning</u> Dr. Peter Stone, Professor, Computer Science, University of Texas at Austin Dr. Garrett Warnell, Research Scientist, Army Research Lab South
1415-1500	<u>Transitioning Technology and People out of Academia</u> Dr. Mitch Pryor, Research Scientist, Mechanical Engineering, University of Texas at Austin Dr. Brian O'Neil, Research and Development Engineer, Los Alamos National Labs
1500-1545	<u>Reliable Autonomous Robotics: Perception, Learning, and Trust</u> Dr. Maruthi Akella, Professor, Aerospace Engineering and Engineering Mechanics, University of Texas at Austin Dr. Todd Humphreys, Associate Professor, Aerospace Engineering and Engineering Mechanics, University of Texas at Austin
1545-1600	NETWORKING BREAK
1600-1645	<u>Human-Robot Interaction and Disaster Robotics</u> Mr. Coitt Kessler, Robotics for Emergency Deployment Team, Austin Fire Department Dr. Julie A. Adams, Associate Director of Research, Collaborative Robotics and Intelligent Systems Institute, Electrical Engineering and Computer Science, Oregon State University
1645-1700	CLOSING REMARKS Lieutenant General Theodore Martin, Deputy Commanding General, U.S. Army Training and Doctrine Command (Via Video)
1700-2000	<i>No-Host Social (directly following closing remarks)</i>

- 0745-0800** [Opening Remarks](#)
Brigadier General James P. Bienlien, G 3/5/7 Futures and Concepts Center, U.S. Army Futures Command
- 0800-0845** [Accurate Technology Forecasting to Enable Army Operational Overmatch into the Deep Future](#)
Dr. Troy Alexander, Technology Forecasting Lead, Combat Capabilities Development Command (CCDC), Army Research Laboratory
- THEME: FUTURE OF SPACE AND ETHICS**
- 0845-0930** [Robotics in Space](#)
Dr. Julia Badger, Project Manager, Robotics Intelligence for Human Spacecraft Team, NASA
- 0930-1030** [PANEL: Ethics and the Future of AI Innovation](#)
Moderator: Dr. Ken Fleischmann, Associate Professor, School of Information, University of Texas at Austin
Dr. Jakki Bailey, Assistant Professor, School of Information, University of Texas at Austin
Dr. Danna Gurari, Assistant Professor, School of Information, University of Texas at Austin
Dr. Matt Lease, Associate Professor, School of Information, University of Texas at Austin
- 1030-1045** **NETWORKING BREAK**
- 1045-1130** [Hypersonics and Autonomy in Near Space](#)
Dr. Alex Roesler, Deputy Director, Integrated Military Systems Center, Sandia National Labs
Dr. Gary Polansky, Chief Scientist for Hypersonic Technology Development and Applications, Sandia National Labs
- 1130-1230** [Space Traffic Management and Situational Awareness](#)
Dr. Moriba K. Jah, Associate Professor, Aerospace Engineering and Engineering Mechanics, University of Texas at Austin
Dr. Diane Howard, Adjunct Professor, School of Law, University of Texas at Austin
- 1230-1345** **NETWORKING LUNCH** (Briefing by Michael C. Sekora, Founding Director Socrates Project)
- 1345-1445** [PANEL: Space Law Games](#)
Moderator: Mr. Matt Bold, Lockheed Martin
Mr. Daniel Michon, J.D. Candidate, University of Texas at Austin School of Law
Ms. Cheyenne Williams, Student, University of Texas at Austin
+ Student Panelist
- 1445-1530** [Planet Habitability and Life Forms: Xenobiology for Military Applications](#)
Dr. Andrew D. Ellington, Professor, Molecular Biosciences, University of Texas at Austin
Habitability of Icy Ocean Worlds and the Europa Clipper Mission
Dr. Krista Soderlund, Research Associate, Institute of Geophysics, University of Texas at Austin
- 1530-1545** **NETWORKING BREAK**
- 1545-1630** [Science Fiction and the Future Operational Environment](#)
Ms. Martha Wells, Science Fiction Author, *Murderbot Diaries*
- 1630-1645** [CLOSING REMARKS](#)
Mr. Thomas Greco
Director of Intelligence, Deputy Chief of Staff, G-2, U.S. Army TRADOC
- 1645** *Conference Adjourns*

Related Links

Follow this link to the playlist featuring all presentations from the Disruption and the Future Operational Environment conference on YouTube:

https://www.youtube.com/playlist?list=PLx2Zn7hPXT7fh0UcE_JkGbSq1ziEO3hc4

Follow this link to find all presentations on the Mad Scientist APAN page:

<https://community.apan.org/wg/tradoc-q2/mad-scientist/p/disrupt>

The Modern War Institute at West Point released a series of podcasts recorded at the conference:

The Future Battlefield with former Deputy Secretary of Defense Mr. Bob Work -- <https://mwi.usma.edu/mwi-podcast-former-deputy-defense-secretary-robert-work-assesses-future-battlefield/>

The Future of Space with Dr. Moriba Jah, Professor in the Department of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin -- <https://mwi.usma.edu/mwi-podcast-future-hold-us-military-space/>

How the Army is Preparing for the Future Battlefield with Major General John George, Deputy Director of the Army's Futures and Concepts Center and Mr. Jay Harrison, Command Innovation Officer at Army Futures Command -- <https://mwi.usma.edu/mwi-podcast-army-preparing-future-battlefield/>

Science Fiction and AI with Ms. Martha Wells, author of the award-winning Murderbot Diaries series – Pending this summer

National Defense Magazine – “Army Uses Mad Scientist Gathering to Explore Emerging Technologies” by Connie Lee -- <https://www.nationaldefensemagazine.org/articles/2019/5/31/army-uses-mad-scientist-gathering-to-explore-emerging-technologies>