Crowdsourcing the Future of the AI Battlefield

#AIBattlefield

Intro

On 10 October, the U.S. Army's TRADOC G-2 Mad Scientist Initiative launched a crowdsourcing exercise to explore the possibilities and impacts of Artificial Intelligence (AI) on the future battlefield. For good reason, much has been made of AI and Machine Learning (ML) and their use in enabling lethal autonomy on the battlefield. While this is an important topic, AI's potential application is much broader and farther reaching, enabling future warfare at machine speed and disrupting human-centered battlefield rhythms.

Using the Mad Scientist Laboratory and social media, we received submissions from approximately 115 participants from military units, Government agencies, private tech companies, academia, and a number of non-DoD/Government associated sources. These submissions were diverse and rich in depth, clarity, and quality. The content from this exercise has been distilled into two sections: 1) cross-cutting takeaways impacting every aspect of the future battlefield; and 2) highlights of ideas binned into categories supporting upcoming Army Wargames on Intelligence, Surveillance, and Reconnaissance; Logistics; and Command and Control.

Mad Scientist is extremely appreciative of all the feedback and submissions received. We intend for this product to be used in future wargaming events, future horizon scanning, and the general framing of future thinking and planning for the development and use of AI systems and entities.

Cross-Cutting Takeaways

Invisible AI: AI will be so pervasive across the battlefield that most of its functions and processes will take place without warfighters and commanders noticing. There won't be an On/Off button per se, similar to cellular service, smart device functions, or cyber operations. The wide proliferation of AI entities from devices to platforms to even wearables means it will not be an isolated domain, but rather will permeate ubiquitously and seamlessly across the battlefield.

Speed it Up: AI will not only speed up existing processes and cycles – i.e., the military decision-making process (MDMP), the intelligence cycle, the targeting cycle – but it will also likely transform them. Many of these cycles and processes have evolved and proven their effectiveness in a human-centric

environment. Some contain consecutive steps that may no longer be necessary when tasks are assigned to intelligent machines. Critical, time-sensitive, but often tedious work that is carried out by hundreds of military staff members in many hours could be accomplished in minutes by AI, leading to flattened command structures, smaller staffs, and significant demand and signature reduction on the battlefield. All of this will result in **battlefield optimization** and will induce hyperactivity in combat – rapidly changing battlefield rhythms.

***Coup d'œil* / Freeing up Warfighters and Commanders: AI intelligence systems and entities conducting machine speed collection, collation, and analysis of battlefield information will free up warfighters and commanders to do what they do best -- fight and make decisions, respectively.** Commanders can focus on the battle with *coup d'œil*, or the "stroke of an eye," maintaining situational awareness without consuming precious time crunching data. Additionally, AI's ability to quickly sift through and analyze the plethora of input received from across the battlefield, fused with the lessons learned data from thousands of previous engagements, will lessen the commander's dependence on having had direct personal combat experience with conditions similar to his current fight when making command decisions.

Spectrum Management and Common Operational Picture (COP): The future battlefield will be increasingly complex with the cyber, air, and space domains, as well as electromagnetic spectrum becoming difficult to see, manage, and deconflict. Exacerbating this problem is the enormous growth of the Internet of Things – eventually the Internet of Everything – and even more importantly, the Internet of Battlefield Things. **AI will be critical in processing and sustaining a clear COP in this overwhelmingly data-rich environment of sensors, emitters, systems, and networks.**

Learning Things and Collaborative Entities: AI will facilitate a host of new learning things on the battlefield – i.e., weapon systems, munitions, vehicles, wearables [exo-skeletons] – and a multitude of collaborative entities – sensors, systems, and platforms. This battlespace of learning things will not supplant our need for Soldiers that use and operate them, but it will enhance them as Warfighters.

Resilient and Layered AI: In order to effectively utilize AI across the battlefield, the Army will need resilient and layered AI, including on-board services, localized collaborative systems, and cloud services that do not rely on persistent connectivity. Some AI entities will need to be proliferated at the tactical level, creating a veritable network that can still effectively operate with degraded/disrupted nodes.

New Required Capabilities and Skillsets: The advent of AI across the battlefield will require a multitude of new capabilities and skillsets to implement, maintain, and maximize AI entities. As with the contemporary drive to

recruit Cyber talent into the ranks, the Army must plan on competing with the private sector for the most talented and capable recruits in new AI job fields.

Adversarial Risk: A capability/vulnerability paradox is inherent with AI, with its machine speed capabilities being vulnerable to the vast array of data input sources that it needs to operate. AI's underpinning data and algorithms are vulnerable to spoofing, degradation, or other forms of subversion. This could lead to the erosion of Soldier and Leader trust in AI, and also necessitates more transparency to strengthen the man-machine relationship. Enemies will seek to exploit this relationship and trust.

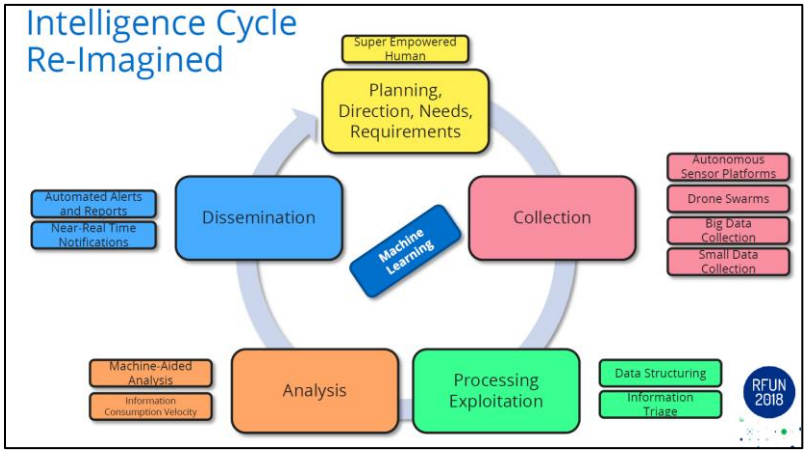
Highlights of Ideas

Data Analytics, Sensors, Intelligence, and Effects:

AI will be distributed throughout the battlefield. Smart sensor networks will pre-process data across domains. Aggregators will interpret all-source information and pre-prioritize, helping human operators focus on what matters in the moment. (@vpkivimaki)

AI will be the synchronizer and the analysis behind thousands of battlefield sensors (IoBT) and millions of commercial sensors (IoT). Diversity of sensors will need AI to piece signatures into meaningful indications and warnings or answers to Commander's Priority Intelligence Requirements (PIR). (Computer Visioning, Matty Squarzoni)

[AI can] automate the review of initial collect to determine cloud cover issues, obstructions, etc. This could lead to selection of alternate sensors or rerouting one collector away while another takes over with a different phenomenology, or altering the angle of approach for better view. (Peter Schwartz)



Currently the military is fixated with geospatial and text analytics. Going forward, the integration of audio forensics, smell, taste, and other factors further define and

characterize. Using AI for noise or signals signature exploitation may be far more relevant than current intelligence analysis paradigms. (Frank Prautzsch)

Complex and cluttered environments will breed entropy and the need for deconfliction among sensors that all respond positively to the same stimulus or event. (Frank Prautzsch)

AI will improve airspace deconfliction, allowing indirect fire systems to rapidly and autonomously clear fires in an air domain congested w/ manned & unmanned systems. (MadSci)

Perform sentiment analysis of OSINT test/audio/video data to assess the local population's view of US and coalition forces during competition below armed conflict. (Peter Schwartz)

Use cell phone call patterns of persons of interest to build a profile based on their network topography and once that node drops out, use AI to monitor for the same pattern when it re-establishes itself on the network. This could also be applied to social media or data that allow nodal connections to be mapped and strengths to be measured. (Dr. Damron)

Collaborative AI/ML Telemetry. Wireless Mesh Networking (MANET) interfaces in mobile formations, and space links between AI nodes in the wild will facilitate machine cognition/collaboration from other machines and sensors....not from humans. Platforms will attain inter- and intra-machine collaboration…not just networking. (Frank Prautzsch)

Multi-AI robotics on a common platform. Wireless multi-AI nodes could be on a platform. In such a situation, multiple flexible wireless interfaces connect AI nodes on a common platform without cables. (Frank Prautzsch)

AI is the foundation for collaborative swarming and cross domain swarming in support of Multi-Domain Operations. (MadSci)

- **Smart Weapons**

Beyond smart munitions – maybe learning munitions. By embedding encoded policies in automatically targeted guns, the targeting function can be enhanced by integrating real-time information about the target, wind, environment, terrain, altitude, and collateral impacts and be updated in real-time with new intelligence. (Keel)

Adversaries can be identified by their characteristics and behaviors. Adaptive weapon systems could behave according to a pre-defined “force continuum;” always ready and always situation aware. (Keeley)

AI capability automating EW C2 duties. Independently select and identify targets (radio stations, communication systems, radars, long-range radar aircraft, and satellites). Decide how to more effectively suppress the enemy, choose the most appropriate

jamming stations for the required purpose, specify the sequence of actions, and monitor operation. (FMSO)

Cyborg/Assisted AI Body/Skin Networks. Soldiers will rely upon greater wearable AI features for C2, human telematics and performance, and integrated senses (not sensors). Not just imagery and audio... but also haptic touch, electronic sniffing, and even taste, all of which are major inputs to an AI/ML wearable artificial sense architecture. (Frank Prautzsch)

AI enabled smart contact lens that tracks eye motion, reads documents, discovers relationships, makes recommendations, provides analysis and pushes to a heads up display. (Christopher Monchamp)

Decision-Making:

AI can free up leaders to clearly consider more factors and make better decisions - allowing them to command more and research and analyze less. AI should allow humans to do what they do best in combat – be imaginative and compel others, while the AI tool finds, processes, and presents the needed information in time. (Brady Moore, IBM)

There is potential to use the same reasoning techniques with AI based on fusion analysis (i.e., data, communication, critical thinking, and research) which reaches a conclusion and an assessment within minutes instead of hours. (SFC Christopher Monchamp)

Use AI to support decision-making in high-stakes, time-critical situations with ambiguous or incomplete information. Leaders have to make decisions even when circumstances - which include the proverbial “fog of war” - mean they effectively can’t see their environment. AI can make sense of patterns and trends in data and can help fill in the blank spots of information and create a more accurate picture. (Brady Moore, IBM)

AI Personal Assistant Technology with access to Open Source and Classified Databases (SIRI with a Security Clearance) (Christopher Monchamp)

The ultimate goal - if we’re thinking of the greatest level of utility for AI on the battlefield - is a Course of Action (COA) Advisor that would take into account all the factors relevant to military decisions and present the commander with an assessment based on the facts at hand, a comparison with past performance, and a consideration of future states. (Brady Moore, IBM)

AI can simultaneously create, analyze, compare alternate futures at different times to support decision making (@jameskgreer77)

AI evaluation of Analysis of Competing Hypotheses (ACH) - Using AI to evaluate the potential outcomes of various secondary decisions may assist during the Military Decision Making Process (MDMP). By providing probabilities of the enemy commander's responses in the action reaction phase of planning, we may better predict 2nd/3rd order of effect to our Commander's decisions. (CW3 Charles Davis)

Monitor human developed COAs beside computer generated COAs to gain the advantage of machine speed and information load and human intuition, psychology, and real world dynamics. (Mary Beth Ainsworth, SAS)

AI will eliminate the need for large staffs. Analysts will be replaced with computer analysis coupled with AI. (@mike_clowser)

Deep Natural Language Processing (NLP) System can significantly improve a commander's decision making capability by sorting through the mountain of unstructured text that our Army maintains in the form of past information (e.g., Lessons Learned) and current information. Artifacts from previous operations can be used in planning to avoid past mistakes or negative outcomes. Data from the present can be immediately surfaced for relevance if their contents meet Commanders' Critical Information Requirements (CCIR) or Priority Intelligence Requirements (PIR). (Brady Moore, IBM)

Humans are susceptible to cognitive biases and these biases sometimes result in catastrophic outcomes, particularly in the high stress environment of war-time decision-making. AI offers the possibility of mitigating the susceptibility of negative outcomes in the commander's decision-making process by enhancing the collective Emotional Intelligence (EI) of the commander and his/her staff. (Vincent Duenas)

In both Megacities and Multi-Domain Warfare, U.S. forces will find themselves operating in the blind for extended periods of time in very complex environments. Despite being denied communications, U.S. forces will need to conduct operations and synchronize across units, service branches, domains, and nationalities in order to create temporary pockets of advantage. This requires multiple artificial intelligences that are distributed to, and employed at, the lowest possible levels. (Brady Moore, IBM)

As commanders are presented with very complex and large problems that characterize modern urban combat, AI could help shrink problems to make them more solvable - for instance, find a good subset of information to experiment and help prove a hypothesis. (Brady Moore IBM)

Incorporation of AI/ML tools and algorithms to reduce the time it takes to perform each task of the kill chain to reduce the overall time and get effects on target much faster than we do today and faster than our adversaries. (Mr. Michael Zecca)

AI could revolutionize the Army targeting process – Decide, Detect, Deliver, and Assess. AI can recommend or choose high payoff targets based on enemy capabilities, optimize the collection system to detect these targets, and dependent on requirements for human decision making, choose the best engagement method and deliver munitions. (Paper CW3 Jesse Crifasi)

Effective employment of drone swarms in support of military operations requires the collective decision-making algorithms of autonomous systems to possess more freedom of action. The algorithms will enable individual drones to independently coordinate decisions and produce behaviors to support a collective aim and keep up with the speed, scope, and complexity of the future operating environment (MAJ Clayton Schuety and MAJ Lucas Will)

The military can use AI for automated rule-based reasoning approaches to improve sense making in cyberspace operations, network mapping, and vulnerability identification and patching. (Will Smith, from Trent, Stoney and Lathrop, Scott, A Primer on Artificial Intelligence for Military Leaders, Small Wars Journal (22 August 2018))

[AI can] automate the Primary, Alternate, Contingency, Emergency (PACE) plan to seamlessly and transparently switch communications networks and waveforms based on network metrics (availability, bandwidth, congestion) and message priority. (Peter Schwartz)

AI can continuously monitor GPS signals and assess the level of integrity (trustworthiness) to mitigate mission risk due to spoofing, jamming, or interference by comparing with other on-board sensors and knowledge of expected platform dynamics. (Peter Schwartz)

Logistics:

- **Predictive Logistics**

Just in Time logistics could be a deadly nightmare for a military unit. But what about "Just Ahead of Time" logistics? Just Ahead of Time logistics would get the needed supplies to the end user not at the moment they were needed but just ahead of when they were needed. How could this be done using AI? (Peter Schwartz)

AI services can observe mission planning activity and predict what the supply requirements will be in the near future, preparing those supplies in advance of urgent need. This extends to mission expendables like ammunition as well as to predictive maintenance of the vehicles used in the missions. (Ted Hromadka)

AI can predict fuel consumption and vehicle maintenance to prolong vehicle costs and operational time “working” and not “refueling/fixing.” Using vehicle sensors and past data. (@kennetharchi)

Unattended remote AI systems. IoT devices consist of a sensor, actuator, and a communications device. Each of these devices will be spectrum dependent, and likely not just on commercial or existing military bands. While the devices are of lower data rates and throughput, they still accumulate the need for spectrum. These distributed nodes and advanced M2M capabilities allow for predictive maintenance, predictive parts failure and reorder, predictive systems failure and recovery analysis, and active monitoring and reordering of stocks being consumed. (Mr. Frank Prautzsch)

AI as a high payoff target because it becomes so critical to logistics and operations (Mr. Joseph Stanley)

Other Battlefield Applications:

- **Adversarial Implications**

Recursive Deep Neural Network (DNN) AI of the future will be trained to mimic unconventional and conventional peer and near-peer adversaries and use game theory to play out strategy options millions of times to generate success probabilities to inform decisions. (@DataSciBurgoon)

Adversarial Computing will become the new battlespace, where humans driven by information are the targets, and the "automation of influence" is the weapon. Creating and responding to strategies and tactics to generate that influence will define the offense. Recognizing and responding to that influence will characterize the defense in the new battlespace. (Adversarial Computing & Automation of Influence, Keeley)

Identification of enemy AI dependencies and weaknesses. Development of counter AI and AI deception practices. (Peter Schwartz)

A number of governments around the world lack the resources and/or funding to acquire or develop AI tools for the conventional battlefield. They may seek cheaper, alternative AI capabilities that would facilitate advantages over the enemy in non-military areas. This approach may prompt these governments to search for unique AI technologies in obscure, gray/black markets -- a domain we should watch as we attempt to describe the future operational environment. (FMSO)

As with any other enabling technical multiplication capability, the ability to deny or spoof AI will draw similar parallels to EW. Denial and spoofing tactics will assist in derailing enemy systems, deriving fake C2, and interpreting data and intelligence incorrectly. (Frank Prautzsch)

- **Information Ops/Social Media**

The military can use AI for Information Operations by developing numerous realistic, consistent messages tailored to target individuals and groups. (Will Smith, from

Trent, Stoney and Lathrop, Scott, A Primer on Artificial Intelligence for Military Leaders, Small Wars Journal (22 August 2018))

Consider an AI technology capable of engaging recruiters of terrorist groups via social media or email. The tool could effectively pose as a prospective recruit in order to gather information on terrorist recruiting pipelines and other aspects of the organization. AI would facilitate the tool's ability to use a number of foreign languages (including dialects and other nuances of native speakers), false IP addresses, GPS locations, photographs, social media histories, and other authenticity markers to make the "potential recruit" as believable as possible. The program would be able to essentially pass a Turing Test against a terrorist group's recruiter. (FMSO)

- **Battlefield Optimization**

Analyze data collected from Combat Training Center (CTCs) and other instrumented live training events to discover the major factors that lead to fratricide. (Peter Schwartz)

AI can properly assign values to tasks and order them in the most effective way possible. And assign tasks to personnel/vehicles depending on current workload, proximity, classification, status etc... then point to service location on a map (@kennetharchi)

- **Spectrum Management**

The military can use AI to improve communications systems by classifying interference and optimizing spectrum usage; AI could detect and characterize suboptimal network performance and respond autonomously to maintain communications links. (Will Smith, from Trent, Stoney and Lathrop, Scott, A Primer on Artificial Intelligence for Military Leaders, Small Wars Journal (22 August 2018))

AI will characterize signals and monitor / manage the electromagnetic spectrum. AI will help formations attack adversaries' C2 and navigate congested / contested nets. (MadSci)

IoT devices consist of a sensor, actuator, and a communications device. Each of these devices will be spectrum dependent, and likely not just on commercial or existing military bands. While the devices are of lower data rates and throughput, they still accumulate the need for spectrum. These distributed nodes and advanced M2M capabilities allow for predictive maintenance, predictive parts failure and reorder, predictive systems failure and recovery analysis, and active monitoring and reordering of stocks being consumed. (Mr. Frank Prautzsch)

AI uses life-monitors to diagnose wounds and automatically relate data to a central medical unit. AI controlled compression cuffs (tourniquet) regulates blood flow to sustain user and preserve tissue limiting amputation. (@BelovedofGod)

AI can predesignate potential “bad spots” in a crowd or street. “Bad corner, Bad window” and assign them values using bullet trajectory. Then give data to the boots on the ground for extra visualization of the possible situation. (@kennetharchi)

AI will serve as trusted combat engineering advisors in the subterranean and urban combat theaters of the future; identifying structural weaknesses of obstacles, automatically updating routes for hazards for maneuver (@DataSciBurgoon)

Conclusion

These takeaways and highlights of ideas illustrate the many ways AI can be implemented across the future battlefield. Machine speed warfare will be enabled by AI; it will not be limited to just lethal autonomy. The functions of so many other parts of combat – C2, ISR, sustainment, medical, etc. – can be accelerated and improved; not just “warheads on foreheads.”

While we explored where AI could enhance battlefield operations, there are also implicit considerations that must be accounted for in the future. These include the ethical dilemmas and concerns associated with employing AI in so many different ways. Lethal autonomy is a hot button issue due to its life or death implications. However, AI assisting other warfighter functions will have significant impacts on the battlefield.

A second major consideration is what impact AI has on Army learning and training. The Army will not only have to incorporate the subject of AI in its learning but will also utilize AI in its learning. Additionally, AI will be required to support Field Training Exercises and other major training events to work through all of the second and third order effects resulting from a much more compressed battle rhythm.

This document is meant to be a primer that will help shape and frame the Army’s thinking about AI in the future and its potential application across the battlefield. It is a snapshot of the explorative thought exercises on-going around the country. If you have any questions about the details or specifics of any idea or takeaway within this document, please contact us at:

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so that we may connect you to its originator(s) and progress this vital conversation.