LEVERAGING INNOVATION TO MODERNIZE DECONTAMINATION

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The current Chemical, Biological, Radiological and Nuclear (CBRN) decontamination system is based upon supporting technologies that have remained basically unchanged for decades. While there have been some relatively minor changes to the decontamination process, it is still resource intensive, requiring technical understanding, excessive troop support, massive amounts of water, proximity to the hazard, many hours to complete, with sometimes questionable results, a very identifiable, large, and difficult to defend, layout that presents a signature management challenge. The CBRN technical support available to conduct these activities is typically sparse, often requiring that a unit task organize to conduct what is basically a do-it-yourself operation.

Figure 1. Soldier conducting an equipment decontamination mission

In typical practice a unit that is contaminated must delay the conduct of its mission, often “going back” for decontamination to restore combat power or logistics delivery

capability. With respect to the Chemical threat, physics rewards rapid mitigation and complicates the process if it is delayed. The demands of a technology enabled battlefield require dispersion, agility, and signature management that is difficult, if not impossible, to achieve with the legacy decontamination capability. An agile capability that is tailorable, that requires fewer resources, is capable of being delivered at the point of need and presents a signature less likely to be targeted has the potential to more quickly return combat power or logistics flow.[1.] Early discussions with the user revealed they felt that massively contaminated vehicles and equipment demanded too many resources to support future tactical operations. Leveraging developing programs of record, a crew conducted, early mitigation activity, was developed termed “Tactical Decontamination”. The technique used an equipment set that could be on vehicle. A more through process was still required but the philosophy of “just enough” prompted research into how equipment becomes contaminated and what would be adequate to mitigate contamination. “Mitigate” is now used in the context of managing contamination, mitigating the hazard to the greatest extent practical to reduce operational risk to warfighters while simultaneously informing maneuver commanders with the requisite knowledge to make risk-informed decision making. There are two primary ways equipment can become contaminated. Agent can be delivered as an “agent rain” or agent can be transferred to the equipment as it passes through a contaminated area. Direct targeting is difficult, but transfer could be common. Of the two, transfer is more easily addressed.

US Army Combat Capabilities Development Command Chemical Biological Center (CBC) manages a robust 6.2 portfolio of supporting technologies that, if used in a

multi-disciplinary, integrated, redesigned process, could address the limitations of the current system.

CBC conceptualized an ad hoc process, termed CBRN Insight, (Innovative Novel Systems Integrating Groundbreaking Harnessed Technologies), to engage the user in an innovative, collaborative approach to addressing solution space. The central concept was early and continuous engagement between the CBC, and the US Army Maneuver Support Center of Excellence (MSCoE), or other user, to define and build virtual and physical prototypes with the intent of conducting multiple learning events in virtual and physical experimentation. The major challenge was not technology, or the capability to prototype, it was a lack of funding to conduct virtual and physical prototype development. There was a need to generate interest and to seek partners. The CBC LNO, working closely with the Army Chemical School (CBRNS) and MSCoE, sought approaches that could provide “leap ahead” capabilities to address user needs. The legacy development approach was cumbersome, unresponsive and expensive, often offering “stovepipe” solutions that were overcome by changes in the evolving operational environment. A virtual team was formed to conceptualize multi-disciplinary integrated technology approaches. It was decided to conceptualize leveraging the technology portfolio by defining a cross disciplinary “Capability Set” (CAPSET) that addressed the threat, cognitive and physical workload, emerging technologies, alternative operational tactics, techniques and procedures, process outcomes and process time as well as costs. It was decided to create a “quad chart “and a discussion paper to socialize the approach[2].

Experiment venues supporting Army modernization are oriented upon the priorities of Long-Range Precision fires; Next Generation Combat Vehicle; Future Vertical lift; Air and Missile Defense; Network (Cyber) and Soldier lethality. The CBRN threat has the potential to disrupt each of these capabilities to the degree of 30% or more[3]. A series of virtual experiments were planned and conducted to inform concepts and requirements developers. This experiment series, collectively entitled Combined Arms Maneuver in a Contaminated Environment (CAMCOE), examined the impact of a CBRN environment upon combat operations. The experiment was heavily focused upon maneuver combat operations. Conducted in conjunction with Maneuver Center and including a contingent from the Marine Corps, as well as significant involvement from the operational force, a number of vignettes were defined and executed in a Tabletop exercise. Over 40 operational challenges or "gaps" were identified[4]. These gaps were defined across the areas of Doctrine, Organization, Training, Materiel, Leader education, Personnel and, to a lesser extent, Facilities (DOTMLP-F).

As the scenario vignettes of CAMCOE played out, it became obvious that the legacy approaches to CBRN decontamination were challenging in the current environment and extraordinarily difficult to accomplish in a future conflict against a peer or near peer competitor. Chemical School and Maneuver Support Center established priorities for resolution of these challenges. One challenge was associated with equipment decontamination. Examination revealed that some improvement could be realized by Doctrine changes. Those changes were immediately addressed with proposed changes to Tactics, Techniques and Procedures, the effort was entitled Tactical Decontamination, a procedure that incorporated near term programs of record and

modified process. That effort was leveraged to inform the CAPSET. It was clear that a simple insert of a new technology application would not be adequate to support next generation issues associated with combat with a peer or near peer competitor. In response, a revolutionary, new conceptual approach was proposed focused upon leveraging emerging technologies, current programs of record, and commercial capabilities to realize a semi-autonomous process with improved precision, reduced resource burden, the capability to push the process to the point of need, reduce the targetable signature of the process and capable of being tailored to support agile operations while complimenting the Tactical Decontamination doctrinal change. A quad chart and supporting discussion paper were prepared and staffed.

The Deputy Commandant of the CBRNS challenged the CBC team to create a video simulation of an autonomous process to illustrate how integrated emerging technologies could demonstrate the application of autonomous behaviors to a modified equipment decontamination process provided by the MSCoE Protection team. Working closely together with MSCoE and CBRNS personnel, a storyboard for the simulation was prepared and handed off to the audio-visual technology developers in the CBC Advanced Design and Manufacturing Division. Inspired by a commercial Independent Research and Development effort, a strawman simulation was developed with a narrative and presented to CBRNS/ MSCoE for their approval. The resulting simulation depicted an agile semi-autonomous process, that leveraged front end technical information using a unique item identifier (UII) to inform both humans and autonomous machines of likely transfer locations; a robotic semi-autonomous

prewash; contamination mapping using colorimetric disclosure technology; precision application of an advanced decontamination solution; automated post mitigation monitoring and a flexible system to label output in a process with faster process time; the capability to monitor the semi-autonomous process from short range standoff distances; with the capability to deliver mitigation capability to the point of need and return combat power or logistics flow quickly.[5]

Figure 2 (Mitigation NCO remotely monitoring semi-autonomous mitigation operation

Initial funding to form a team and create the video simulation was provided by the Director CBC who approved Semi-Autonomous Contamination Mitigation as an in-house innovation project which would leverage the Center's innovation funding. Lacking a budget line to conduct prototyping, it was necessary to find funding to resource the plan and conduct a proof of principle. The discussion papers and video simulation helped to secure funding to explore autonomous behaviors and demonstrate proof of principle. The project manager obtained additional funding and leveraged other ongoing efforts to conduct an incremental technology development

that integrated a ground robot demonstrator, contamination mapping, and robotic precision solution application. Other necessary components of the initiative, such as technical information handoff, post mitigation monitoring and sorting were partitioned to be addressed later due to a lack of funding.

An ad hoc collaborative team formed with representatives from CBC, Maneuver Support Center of Excellence (MSCoE), the Joint Requirements Office, Defense Threat Reduction Agency- Joint Service Technology Office (DTRA-JSTO), Ground Robotics Center, and Industrial partners with the goal of conducting an incremental series of demonstrations that would prove the principle of applying autonomous behaviors to the challenge of mitigation of contamination. The demonstration effort would be incremental leveraging other on- going technology developments and designing a final integrated proof of principle exercise.

Funding was provided to investigate an unmanned ground vehicle (|UGV), a contamination mapping capability, and applying autonomous spraying behaviors to surfaces. The other supporting activities were unfunded. The CBC LNO to MSCoE reached out to several academic institutions with a proposal to collaborate on a study of the potential to utilize Unique Item Identifiers to hand off technical contamination and administrative information to humans and to autonomous robotics. The LNO collaborated with the University of Missouri Science and Technology to conduct the study as a senior engineering student design project. The LNO had no funds to offer but agreed to mentor the groups as they conducted the project. The university agreed and the semester long project was conducted with three design teams investigating.

Students were provided with purpose designed resource materials and an unclassified discussion of the future combat environment. The project was successful, identifying use cases for QR codes informing both humans and machines. Final reports were provided to the project manager and concept developer. One of the more important findings was a commercial equivalent developed by a major automotive manufacturing firm targeting upon first responders to automotive accidents, advising them on where to cut to extract accident victims[6].

Figure 3. Rapid information exchange of complex data

Photo from Car and Driver magazine.

As a result of the effort, a two-year proof of principle demonstration is planned to follow an incremental prototype development. The MSCoE is periodically advised of progress on the effort and the CBC is actively working with concept and requirements writers on a draft requirements document. Twelve other CAPSET proposals have been prepared and socialized with the MSCoE resulting in three additional draft requirements

documents. This innovative approach leverages Soldier input to shape design, integrates emerging technologies with concepts resulting in state-of-the-art prototype development that informs modernization.

APPENDIX A: END NOTES.

1. Defense Technical Informational Center, Multi-Domain Operations, The Army's Future Operating Concept for Great Power Competition, Technical Report, AD 1083376, 23 May 2019.

2. Capability Set Proposal, CBRN Visibility of Named Areas of Interest, CBC, Engineering Directorate, CBRN Ignite initiative, 24 February 2022.

3. DoD Authorization for Appropriations FY86, Hearings before the Committee on Armed Services, U.S. Senate, Ninety ninth Congress, March 1985, Section 3-2, Page 1536.

4. Combined Arms Maneuver in Contaminated Environment, U.S. Army Maneuver Center of Excellence, ATZK-CIC, 19 October 2017.

5. Semi-Autonomous Contamination Mitigation (SACM) Video Simulation, AFC, CBC, Engineering.

6. Mercedes adds QR codes to Cars in Effort to aid First Responders, Car and Driver magazine, June 4, 2013.

APPENDIX B: AUTHOR BIOGRAPHICAL SKETCH

Mr. James M. “Mike” Cress Sr. is a retired Army officer and civil servant with over 40 years of CBRN capability development experience. His military experience includes multiple combat tours as an Infantry officer and serving time in Special Operations.

APPENDIX C: ILLUSTRATIONS

Figure 1. Soldier conducting decontamination on vehicle, DVIDS SFC J. Intriago, SC National Guard.

Figure 2. Image of mitigation specialist remotely monitoring semi-autonomous spraying of vehicles (from CBC Engineering Directorate, Advanced Design and Manufacture Semi-autonomous Contamination Mitigation (SACM) simulation, B. McNamara)

Figure 3. QR code on Mercedes automobile, informing first responders of appropriate locations to cut open a wrecked car. Car and Driver magazine, June 4, 2013, Jens Meiners.

APPENDIX D: ACRONYMS/TERMS

CAMCOE. Combined Arms Maneuver

CAPSET. Capability Set

CBC. Chemical, Biological Center

CBRN. Chemical, Biological, Radiological and Nuclear

CBRNS. Chemical, Biological, Radiological and Nuclear School

DTRA JSTO. Defense Threat Reduction Agency- Joint Service Technical Office.

JRO. Joint Requirements office.

LNO. Liaison Officer

MCoE. Maneuver Center of Excellence

MSCoE Maneuver Support Center of Excellence

QR code. Quick Response Code

UGV. Unmanned Ground Vehicle

UII. Unique Item Identifier