Capability Assessment of Test and Live Training Systems for Real-Time Casualty Assessment

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ABSTRACT

The Army needs the ability to characterize the effectiveness of test and live training systems to improve realistic training and real-time arbitration of casualties. For years, the Army testing and live training communities have strived to develop a robust Real Time Casualty Assessment (RTCA) capability. Currently, both communities are working closely to develop the ability to characterize the degree to which specific, identified capability upgrades to test and live training systems could improve RTCA. This project leveraged a capabilities based assessment method developed for the USMC Squad Immersive Training Environment (previously published as an I/ITSEC paper- Johnston, Dunfee, et al., 2012). This paper describes the methods and findings of the Systematic Team Assessment of Readiness Training (START) method as it was applied to a use-case of the Bradley Fighting Vehicle (BFV) crew training. A baseline capability assessment of the live training environment for the BFV is described in terms of its ability to support effective live Force-on-Force (FoF) training and RTCA. We describe how the START method was employed to establish environmental attribute (e.g., battlefield effects) capability gaps that are used to prioritize investments in test and live training systems based on the degree to which the investments could improve training and RTCA effectiveness. Using the methodology, quantitative and qualitative data on current testing and training capability was collected. The results of this data collection will be presented in this paper. This is a collaborative effort among the Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI), the Army Test and Evaluation T&E Command, the Naval Air Warfare Center Training Systems Division (NAWCTSD), and the US Army Research Laboratory Human Research and Engineering Directorate (ARL-HRED).

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INTRODUCTION

The Army testing community has strived for years to develop a robust Real Time Casualty Assessment (RTCA) capability for use during operational testing. The Director, Operational Test and Evaluation (DOT&E) released the FY12 Annual Report in December 2012 documenting (p. 315) the following issues:

- New and upgraded combat systems should be evaluated with the exchange of simulated fire between friendly and opposing forces in an operationally realistic environment.
- Force-on-force battles should contain a level of realism to cause Soldiers and their units to make tactical decisions and react to the real-time conditions on the battlefield.
- RTCA is needed to ensure that the simulated engagements have realistic outcomes based on the lethality and survivability characteristics of both the systems under test and the opposing threat systems.
- Future Tactical Engagement Simulations (TES)/RTCA should have such critical attributes of real-world combat engagements as direct and indirect fires, improvised explosives devices and mines, realistic battle damage and casualties, a mix of ground and air vehicles, and a realistic threat force.
- TES / RTCA systems should record the time, space, position; and firing, damage, and casualty data for all players in the test event.

The Army Test and Evaluation Command (ATEC) is discontinuing "test unique" RTCA systems and plans to use Army training systems to perform RTCA functions during OT&E. Therefore, ATEC and the Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI) Program Manager for Instrumentation, Targets and Threat Simulators established a Test and Training Initiative to develop technology requirements and identify gaps for evolving training systems to support Test and Evaluation (T&E). As a result, the Initiative identified the need for an innovative method that could identify, define, and prioritize needed fidelity enhancements to live training capabilities so they could be used for T&E on RTCA. The purpose of this paper is to describe the approach, method, and results of a study led by ARL HRED STTC, NAWCTSD, and PEO STRI, and sponsored by the Army Study Board, that addressed this need.

It is important to note that Army live training capabilities were not evaluated in this study and that these study findings should in no way be interpreted to mean that current Army live training is inadequate. The purpose of the study was to simply identify training capabilities that would need to be *enhanced* so it could support T&E as well.

METHOD

Developed by NAWCTSD, the Systematic Team Assessment of Readiness Training (START) is a non-proprietary, open-use method that employs a series of linked spreadsheets to determine the level of capability of training environments to train Warfighter Mission Essential Tasks (METs) (Sheehan et al., 2009). It produces analytic products that stakeholders can use to conduct Training Analysis of Alternatives (T-AoAs). Its data products can be used to make informed decisions regarding the suitability of upgrades to improve training by expanding the array of METs (individual and/or collective) that can be effectively supported. As described in a previous I/ITSEC paper (Johnston et al., 2012), START was used to support a T-AoA of the USMC Squad Immersive Training Environment for live and virtual training systems.

The main study objective was to leverage past lessons learned (e.g., Johnston et al., 2012, Sheehan et al., 2009) to develop a new and innovative method for determining enhanced fidelity requirements for the live training and T&E environments. The Bradley Fighting Vehicle (BFV) crew mission tasks conducted during live FoF training was adopted as a use case because it enabled the analysis to be highly focused, however, the choice should not be construed as a deficiency in BFV live training. To reiterate, the focus of the study was to establish common fidelity attributes that both the training and T&E communities could review and prioritize

The study method followed the standard START approach which was to first work with Subject Matter Experts (SMEs) to identify and select critical mission tasks. Then the START method was adapted to develop a new approach for having SMEs identify and define the live training environmental attributes, so it was labeled “START-RTCA.” Next we worked with SMEs to identify live training environment attributes critical to authentic MET performance, and then they assessed whether the existing live environment attributes were capable/not capable of supporting training METs. Details about this approach are described next.

Task Analysis

Three BFV training SMEs, that had extensive experience (collectively 50+ years), selected 105 BFV crew METs (36 crew operations tasks and 69 subtasks) as relevant to performing live FoF training. In particular it was important to focus on BFV tasks that present four perspectives that the training and T&E requires. In training, the crew/soldier needs to experience the launch, the ordnance during flight, and the impact effects. In T&E there is a need for an opposing force perspective to see weapons fired from the weapons platform. All METs were considered “equal” in importance for performance to standard, collectively, by the crew and were drawn from official US Army documents, including US Army Training Circular No. 3-21.8 (Infantry Rifle and Mechanized Platoon Collective Task Publication, August 2013), and the US Army Training Circular No. 3-21.12 (Weapons and Anti-armor Company Collective Task Publication, July 2012). Table 1 presents the 36 BFV crew operations tasks. The 69 subtasks focused on aspects of task execution in FoF exercises, for example, executing firing a weapon, engaging static and/or moving targets, providing suppressive fires, and assessing engagement effects.

The mechanized Infantry rifle platoon is equipped with four BFVs and is divided into two elements: mounted and dismounted. The mounted element consists of four BFVs that are organized into the A section with the platoon leader as the section leader and the second BFV as the wingman; and the B section with the platoon sergeant as the section leader and the second BFV as the wingman.

Three nine-man rifle squads make up the platoon’s dismounted element. The rifle squad has two four-man fire teams and a squad leader. Each fire team consists of a: Fire team leader, Squad Automatic Weapon (SAW) gunner, Grenadier, and Rifleman. One of the riflemen in the fire team is designated and trained as the anti-armor specialist and fires the Javelin close combat munitions. The other rifleman is the designated marksman. Based on the mission, the squad can carry the Javelin command launch unit and missiles, as well as a M240B medium machine gun.

Live Training

The Army’s training concept (Army Training Circular No. 7-9, September, 1993) emphasizes that to achieve readiness in the mission-essential tasks, live-fire training must be coupled with Force-on-Force (FoF) training to create a combat realistic environment that is comprised of variables that affect live-fire marksmanship (e.g., mission types, terrain conditions, target type, movement). Before a Live Training eXercise (LFX), personnel should be proficient in areas such as individual weapons knowledge and qualification; range determination and target identification; and the basics of fire control measures and movement techniques in the normal training sequence of “crawl”, “walk”, and “run” phases. LFX tactical exercises address both fire and maneuver with emphasis on LFXs for dismounted infantry to bridge the gap between individual and collective training in the employment and accuracy of weapons and weapon systems, grenade marksmanship, machine gun marksmanship, and anti-armor marksmanship. The analysis described herein took into account the current system of systems live training capabilities that comprise the operationally realistic environment associated with the BFV. Live training is executed in field conditions using tactical equipment enhanced by training aids, devices, simulators, and simulations (TADSS) and Tactical Engagement Systems (TES) for the dismounted individual and crew-served weapons of both friendly and OPposing FORces (OPFOR).

Table 1. BFV 36 Mission Essential Tasks

•Execute hand grenade deployment	•Execute firing M257 smoke grenades launcher BFV	•Direct/conduct "fire for effect" missions
•Engage target with javelin	•Engage with TOW missile on BFV	•Adjust fire priorities as mission progresses
•Engage target with M320	•Detect target using BFV	•Execute call for fire (using CFF format)
•Engage target with M4 using aiming light	•Engage target during UO (Urban Operation)	•Assess engagement effect/distribution of fire
•Engage target with M141 BDM	•Detect different types/levels of threat(s)	•Control Movement of a Fire Team
•Engage target with M203 using NVS PSQ-18A	•Identify different types/levels of threat(s)	•Direct a Driver over a Terrain Route
•Engage target with M240B	•Execute movement under direct fire	•Conduct Movement Techniques by a squad
•Engage target with M249	•React to aerial contact	•Conduct the Maneuver of a Squad
•Engage target with caliber .50	•React to direct fire while mounted	•Conduct the Maneuver of an M2 BFV
•Engage area target with 25mm	•React to indirect fire dismounted	•Misfires
•Engage with 25mm gun on BFV	•React to indirect fire mounted	•Indicator of IED
•Engage with M240c on BFV	•React to misfire of 25mm on BFV	•React to IED

Attribute Definitions

Both physical and functional attribute types and definitions were developed. Leveraging definitions of physical and functional simulation fidelity from Alexander et al. (2015), physical fidelity was defined as the extent to which the physical environment looks, sounds, and feels in terms of the visual displays, controls, and audio. Functional fidelity is the extent to which the physical environment reacts to the tasks executed by the Soldier and crew. The three SMEs participated in defining and providing examples that they considered necessary to bringing about authentic performance of the BFV crew METs. Table 2 lists the physical attributes and definitions. Three categories of "Visual" attribute types emerged with nine specific attributes: Field of Regard, Physical Look, and Visual. The Physical Feel and Touch attribute type had four specific attributes, the Auditory attribute type had four attributes, and Olfactory was a single attribute. Table 3 lists System Response and Timing and Systems Interaction and Accuracy as the functional attributes identified by the SMEs.

Table 2. List of Physical Attributes.

Attribute Type	Attributes	Definition – Conveys realistic:
Field of Regard	Horizontal Field of Regard	range of site on the horizontal (left- to-right) global plain for variable terrains
	Vertical Field of Regard	range of site on the vertical (top-to-bottom) global plain for variable environments

Attribute Type	Attributes	Definition – Conveys realistic:
Physical Look	Environmental Appearance	representation of environmental features and/or man-made objects (close proximity or distant) - including physical properties or distinguishing characteristics (shape, size, color, mass, complexity, irregularity, relative position)
	Battlefield Dynamics	representation of battlefield chaos, dynamics and distractions generated by peoples actions and movement, natural and equipment-induced effects at surface levels and/or in the air
	Casualty Appearance	representation of variable casualties, casualty conditions/wounds (color, shape, irregularity, severity, etc.) and injuries to combatants and civilians of variable body type, gender, race, age
Visual	Visibility Light Level	light levels reflecting time of day or other Convey realistic light levels reflecting time of day or other lighting anomalies -and accommodate night vision illuminating systems
	Visibility Obstructed View	visibility levels affected by air-borne particles and/or natural or man-made obstructions that may inhibit the ability to see clearly (at close proximities or at a distance) or inhibit line-of-sight.
	Visual Perspective / Depth / Angle	representations of distances, changing distances, or angles of approach and arc of objects in the environment (on the ground or in the air)
	Visual Effects	visuals with the appropriate level of detail and acuity to achieve a reasonable level of recognizability.
Physical Feel/ Touch	Environment Feel	representation of meteorological ambient sensations associated with variable atmospheric, weather and/or climate conditions
	Tactile Feel	representation of touch "contact" sensations produced by physical interaction with objects, instruments, or natural elements usually located in the immediate vicinity.
	Haptic Cues	"response" sensations (feedback) when interacting with weapons, tools and equipment or other objects as with the pressure exerted or felt when pushing or pulling, levers, handles, peddles, controls.
	Concussion/ Quake Effects	representation of concussion and quake effects (across the ground and through the air) that may affect feelings of balance, spatial orientation and positional attitude
Auditory	Environmental Sounds	discernible and indiscernible sounds occurring in the environment - whether natural or man-made - including incidental environment sounds, weather sounds, combat sounds, voice
	Sound Signature Bearing/Delay	variable sound tone, volume, pitch, source location, and delays that indicate the source, bearing, direction, distance or origin of an event or activity
	Audible Non Verbal Cues	non-verbal audible sounds where the tenor, frequency, tone, regularity, pitch and/or volume and length of delay provide meaningful and specifically interpretable information (signals, alerts) or other meaningful sound cues
	Verbal Com-munication-direct or mechanical	levels of voice communication (clarity, interference, delay) between and among combatants, civilians, and other voice communication sources
Olfactory	Ambient Odors	odors, fumes, smells of different types of combat environments and engagements that may affect battlefield performance and decision

Table 3. List of Functional Attributes.

Attribute Type	Attributes	Definition – Conveys realistic:
Function	System Response/ Timing	coordinated and appropriately timed system responses to user input - where input or activity of the user influences the reaction, response, output of a system, control or display with appropriate timing/delay
	Systems Interaction / Accuracy	coordinated and appropriately timed system responses to input originating with other systems or system components - where input or activity from one system influences the reaction, response, output or displays of another system, control or display

Attribute-to-Task Criticality Assessment

Next, the "Attribute – to – Task" Criticality Assessment was conducted to identify the attributes most critical to performing each of the BFV crew tasks in FoF missions. An analysis spreadsheet was used as the ratings collection tool. Tasks and attributes were inserted into the spreadsheet page, with the 105 tasks and subtasks listed in the first column, and the 20 attributes listed in the top row.

Two BFV training SMEs worked together to provide a consensus rating of how critical an attribute is for bringing about authentic task execution. They used a 6-point criticality rating scale labeled as: 0 - Not Applicable; 1 – Not Critical; 2 – Nice to have but not Critical; 3 – Critical; 4 – Highly Critical; and 5 – Absolutely Critical. For example, for an attribute to be rated as "not critical" with a score of "1," SMEs would have to agree that the attribute is irrelevant and contributes nothing to task execution. For an attribute to be rated "absolutely critical" with a score of "5," SMEs would have to agree that a task cannot be executed without the particular attribute. SMEs took a day to formulate their consensus ratings, and then inserted a single rating into each of the spreadsheet cells.

Only the olfactory attribute was found to consistently have low or no criticality to authentically performing the METs in this use case, and was therefore dropped from further analyses.

Attribute-to-Task Capability Assessment

Following this, the "Attribute – to – Task" Capability Assessment was conducted to identify how capable the attributes of the live training environment were in bringing about authentic task performance. A new spreadsheet page was created with the same 105 tasks and subtasks listed in the first column and 19 Attributes listed across the top row. Only the cells that had attribute criticality ratings of 3, 4, and 5 were available for rating. Cells that had attribute criticality ratings of 2, 1, and 0 were blacked out on the spreadsheet.

Next, the same two BFV SMEs worked together to provide a consensus rating of each attribute's capability for bringing about authentic task performance. The rating scale was: 0 - Rating not applicable; 1 - Completely Incapable; 2 - Marginally Incapable; 3 - Borderline Capable; 4 - Reasonably Capable; and 5 - Fully Capable. For example, for an attribute to be rated "completely incapable" with a score of "1," SMEs would have to agree that the live environment is "completely incapable" of providing the attribute, and the attribute, as presented, prevents task execution. For an attribute to be rated as "completely capable" with a score of "5," SMEs would have to agree that the live environment is fully capable of providing the attribute with no departure from realism, and requires no compensation to support task execution.

SMEs also provided qualitative comments on specific attributes if it was given a capability rating of 3, 2, or 1. The comments provided valuable insight into the specifics of attribute relationships, the nature of the current capabilities; and whether capability enhancements were possible, given restrictions in terms of safety and security of personnel. For example, enhancements to a hand grenade to make it more realistic for testing and training could not include "making it capable of exploding."

RESULTS AND DISCUSSION

Table 4. Rating Legend.

1	Completely Incapable
2	Marginally Incapable
3	Borderline Capable
4	Reasonably Capable
5	Fully Capable

Table 4 is the color-coded legend for the capability rating results shown in Figures 1 through 4. The results of this analytical procedure demonstrated it was successful in distinguishing the importance and capability of these attributes in the ability to provide an environment for realistic task execution.

Each figure presents the attribute type and the number of tasks relevant to the type. Then below this is listed each attribute. Below each attribute is listed the number of tasks SMEs noted were relevant to it alone. Ratings and number of tasks are listed according to the legend in Table 4. For example, Figure 1 presents the findings for the visual fidelity attribute types. In the Field of Regard table there were 88 tasks SMEs selected that were relevant to it. The SMEs also assigned all of these tasks under the attribute – Horizontal Field of Regard (FOR). SMEs rated the live environment mostly Fully Capable (98%) of providing that attribute.

Field of Regard			
88 Tasks Affected (83%)			
Horizontal FOR		Vertical FOR	
88	100%	88	100%
0%	0	0%	0
2%	2	2%	2
0%	0	0%	0
0%	0	0%	0
98%	86	98%	86

Physical Look and Feel					
87 Tasks					
Environment Appearance		Battlefield Dynamics		Casualty Appearance	
84	97%	86	99%	71	81%
0%	0	9%	8	11%	8
0%	0	67%	58	76%	54
0%	0	10%	9	10%	7
1%	1	7%	6	1%	1
99%	83	6%	5	1%	1

Visual							
90 Tasks							
Visibility Light Level		Visibility Obstructed View		Visual Perspective / Depth / Angle		Visual Effects	
57	63%	86	96%	86	96%	89	99%
0%	0	0%	0	16%	14	27%	24
0%	0	0%	0	29%	25	45%	40
0%	0	0%	0	35%	30	9%	8
0%	0	0%	0	0%	0	1%	1
100%	57	100%	86	20%	17	18%	16

Figure 1. Capability Rating Results for Visual Fidelity

It is not a surprise that horizontal field of regard, vertical field of regard, environmental appearance, visibility light level and visibility obstructed view were given nearly fully capability ratings. In contrast, battlefield dynamics, casualty appearance, visual perspective/depth/angle, and visual effects were rated less than reasonably capable. SMEs called out well-known restrictions in achieving these capabilities, such as safety regulations.

Figure 2 presents the capability ratings for physical feel, touch and response. Environmental feel was rated as fully capable, almost three quarters of the tasks were given satisfactory capability ratings for tactile feel and haptic cues. Only concussion/quake effects were given largely less than reasonably capable ratings, with SMEs noting this was understandable since safety regulations also limit exposure to such effects.

Physical Feel / Touch / Response							
105 Tasks							
Environment Feel		Tactile Feel		Haptic Cues		Concussion / Quake Effects	
84	80%	105	100%	105	100%	60	57%
0%	0	18%	19	18%	19	12%	7
0%	0	10%	10	10%	10	67%	40
0%	0	0%	0	0%	0	12%	7
0%	0	1%	1	1%	1	2%	1
100%	84	71%	75	71%	75	8%	5

Figure 2. Capability Rating Results for Physical Feel, Touch, & Response Fidelity

Figure 3 presents the capability ratings for auditory fidelity. Verbal communications was rated as fully capable. About half of the capability ratings ranged from borderline to fully capable for environmental sounds, sounds signature bearing and delay, and audible non-verbal.

Auditory							
82 Tasks							
Environmental Sounds		Sounds Signature (Bearing / Delay)		Audible Non-Verbal Cues		Verbal Comms	
22	27%	51	62%	52	63%	68	83%
14%	3	18%	9	17%	9	0%	0
18%	4	27%	14	27%	14	0%	0
41%	9	24%	12	27%	14	0%	0
18%	4	29%	15	27%	14	0%	0
9%	2	2%	1	2%	1	100%	68

Figure 3. Capability Rating Results for Auditory Fidelity

Figure 4 shows adequate capability ratings for about 50% of the tasks relevant to system response and timing, and about 25% for system interaction/accuracy.

Functionality			
101 Tasks Affected (85%)			
System Response / Timing		Systems Interaction / Accuracy	
101	100%	101	100%
18%	18	18%	18
11%	11	11%	11
12%	12	48%	48
11%	11	4%	4
49%	49	20%	20

Figure 4. Capability Ratings for Functional Fidelity

Task Impact Ranking

The next step in this process was to present the data so that decision makers could understand the impact of the findings, describe the requirements, and then prioritize the best candidates for further analysis. Therefore, a simple "Task Impact Ranking" was developed based on the capability ratings that indicated a need for enhancements.

Table 5 presents the 12 attributes with a majority of ratings at or below borderline capable. They are arranged in order of the physical and functional fidelity attribute type categories listed in Table 2 and Figures 1 through 4. The total number of tasks affected by the low ratings are listed to the right of the attribute.

The far right column shows the task impact ranking that was assigned based on the highest to fewest number of tasks impacted by the lack of an attribute in the live environment. Systems interaction/accuracy received the highest ranking with 77 tasks impacted. However, the four visual attributes collectively had the most impact. Greater than two-thirds to three quarters of the tasks were affected by each visual attribute, with rankings 2, 3, and 4. The remaining attributes impacted half or fewer than half the tasks.

Table 5. Attributes with Task Impact Rankings

Attribute		# Tasks Affected	Task Impact Rank
Physical Look	Battlefield Dynamics	75	2
	Casualty Appearance	69	4
Visual	Visual Effects	72	3
	Visual Perspective/Depth /Angle	69	4
Physical Feel/ Touch/ Response	Concussion/Quake Effects	54	5
	Tactile Feel	29	9
	Haptic Cues	29	9
Auditory	Audible Non Verbal Cues	37	7
	Sound Signature Bearing/Delay	35	8
	Environmental Sounds	16	10
Functionality	Systems Interaction/Accuracy	77	1
	System Response/Timing	41	6

The findings in Table 5 serve to orient decision makers toward prioritizing the attributes that could have the most potential for improving training and T&E. The next step would be to conduct collective discussions that engage the training SMEs, training technology SMEs, research engineers, and program managers to determine the most likely candidates for improvements based on technical risk, and then cost. A way to start the discussion would be to recommend likely candidates under each category based on drilling down a bit into the attribute ratings. It may be best to focus on how to improve attributes that were rated as "borderline capable." Examples are described next.

Physical Fidelity

For example, the visual perspective/depth /angle attribute (see Figure 1) had a rating of borderline capable for 35% of the tasks. Increasing capability on these tasks would possibly improve overall capability to 55%. Improvements in representing distance, changing distance, or angles of approach and arc of objects in the environment (on the ground or in the air) could also have an impact on improving other attributes in this category.

Audible non-verbal cues, sound signature bearing and delay, and environmental sounds all had borderline capability ratings (see Figure 3) that would merit identifying capability enhancements to them. If adequate technical enhancements were identified, then the ratings to increase the overall capability could increase to nearly 60% or higher. This would include providing non-verbal audible sounds where the tenor, frequency, tone, regularity, pitch and/or volume and length of delay provide meaningful and specifically interpretable information, (signals, alerts) or other meaningful sound cues, weather sounds, combat sounds, voice, variable sound tone, volume, pitch, source location, and delays that indicate the source, bearing, direction, distance or origin of an event or activity.

Functional Fidelity

For systems interaction/accuracy (see Figure 4), 48 tasks were rated as borderline capable. If improvements were made in providing coordinated and appropriately timed system responses to input originating with other systems or system components, overall capability could potentially increase to 70%. Similarly, for system response and timing – 12 tasks were rated as borderline capable. If improvements were made in providing coordinated and appropriately timed system responses to user input, the overall capability could potentially increase to 70%.

CONCLUSIONS

The goal of the Army Study Board project was to address the problem of identifying and prioritizing needed improvements in the fidelity of test and live training environments for RTCA. This report described an innovative, systematic method that was developed to demonstrate how to identify the most critical live training environment attributes that are needed for effective FoF training and RTCA during operational T&E. The START-RTCA methodology was developed and applied to conducting a capability assessment of the BFV as a use-case. Capabilities requirements were identified, based on a systematic approach to determining the total number of tasks affected by the lack of fidelity in a particular type of physical and functional attribute.

The top five capability requirements identified were: system interaction/accuracy, battlefield dynamics, visual effects, visual perspective/ depth/ angle, and casualty appearance. These attributes could be selected for further study to identify potential upgrades to improve live training and testing.

The next steps in this procedure would be: prioritize requirements; identify technology enhancements for the BFV use case; identify risks, risk mitigation strategies and costs associated with the enhancements. If gaps cannot be fully addressed by a particular solution or set of solutions, an AoA could be conducted to outline potential strategies for satisfying the gaps to the greatest possible extent.

Listed below are lessons learned from this effort:

- Assemble and manage a dedicated group of SMEs and project-related engineers that can commit to the project timeline helps to achieve study objectives in a fast and efficient manner.
- Discuss with the assembled team the similarities, differences, and nuances of training and testing performance requirements to help shape the mental model of analysis concept of operations, to include developing or leveraging operational definitions and semantics of shared terminologies.
- Develop a use case example very early on to help set the SME interview strategy and provide a framework for capturing fidelity requirements at a low level of granularity. The more detailed input about the sensory

and cognitive cues and feedback required from different perspectives (e.g., shooter, target, and observer) for successful task performance, the richer the analysis to render input for conducting an AoA.

- Develop a matrix of the training technology products and associated capabilities that cross-walk how they are integrated to implement Bradley crew training. This would produce a more complete picture of how the training capabilities work together to influence capabilities and required fidelity. For example the combination of visual, haptic, and aural cues should be described to produce a more accurate set of task attributes.
- Include in the analysis such instructional attributes as an instructor operator station, instructor/controller's roles and responsibilities during exercises, after action review capabilities, and such enabling technologies as range instrumentation and infrastructure. Define how these capabilities are used to triangulate casualty assessments, performance measures, and learning feedback to establish training effectiveness (TE), TE tracking and TE reporting.
- Determine products and capabilities that should be considered in an AoA to include science and technology gaps, long-range product improvements, and other Services' analogous capabilities and products.

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