Exercise Management Considerations for Live, Virtual, and Constructive (LVC) Training

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ABSTRACT

As integrated training events evolve to include Live, Virtual, and Constructive (LVC) entities, multiple safety considerations, inside and outside of the cockpit, need to be considered. The current Navy Aviation Simulation Master Plan (NASMP) states, "Safety must be an integral part of planning and execution. Live blue and red platform displays, training mode functionality and training rules must help mitigate safety risks associated with an LVC environment" (NASMP Policy IV). The Office of Naval Research's (ONR) Science and Technology (S&T) effort, *Virtual and Constructive Representations on Live Avionics Displays* (VCR LAD), has identified multiple areas through interviews and thematic analysis where LVC has the potential to impact integrated training. In this paper, we focus on implications for training exercise management, including Range Training Officer (RTO) and Range Safety Officer (RSO) activities. There are various areas of concern within training exercise management, including delegation of workload amongst personnel (e.g., RTOs, RSOs) and whether existing interface designs and work support tools can adequately support the conduct and oversight of LVC training. Additionally, new positions may need to be introduced and integrated into the exercise management team. Further, new exercise management practices may need to be adopted. This paper presents initial findings and associated recommendations for exercise management technologies, roles, responsibilities, and practices, as well as, future research needed to determine and evaluate specific solutions to those recommendations.

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INTRODUCTION

Large, complex training events, or those falling later in the training continuum (i.e., Fleet Readiness Training Plan (FRTP)), include integrated Air Wing events that involve multiple communities training together to gain experience and qualifications in a "real world" setting. As such, these communities may not be familiar with each other's capabilities or procedures which, stresses the importance of overall safety and exercise management. These events are integral to the overall readiness of aircrew. In the Navy, these events tend to occur later in the months-long deployment preparation period and are often one of the last opportunities air communities have to train together before deployment.

Extensive preparation is required for these live integrated training events to be successful and safe. These events provide the training necessary to meet training objectives outlined in the Capabilities-Based Training and Readiness Matrix (CBTRM). Although crucial, these events are facing increasing challenges including: the cost to operate live aircraft, the difficulty of emulating the advancing capabilities of adversaries, and the difficulty of practicing new capabilities in the limited airspace of existing training ranges (i.e., range encroachment) (CNAF, 2013). These air combat training challenges could be largely overcome by adopting the Live, Virtual, and Constructive (LVC) training paradigm. As stated in the Naval Vision for 2025, "The cost to operate present and future platforms - combined with advanced capabilities that are rapidly exceeding the capabilities of our current training ranges - demands that we innovate in combining live, virtual, and constructive training."

Complex systems are systems that consist of multiple interacting parts which produce emergent properties and non-linear behavior (Bar-Yam, 2004; Hollnagel, 2012; Kasdaglis, 2014). The LVC training paradigm can thus be considered a complex system as there are multiple facets that must interact and there is great variability in how those interactions take form. Predicting and anticipating the behavior of complex systems, like those within LVC training, is challenging due to the dynamic nature, making exercise management especially difficult. Exercise management has adapted over time so that the demands of even the most complex training events can be met. The inclusion of LVC in future air combat training events, while needed, has the potential to disrupt the system in place and thereby introduce safety concerns and greater stress on exercise personnel.

Considerations for the inclusion of LVC technology within air combat training exercises are outlined in the Navy Aviation Simulation Master Plan (NASMP). The NASMP provides guidance and direction for all of aviation simulation, to include LVC technology, in order to achieve the Navy's combat readiness goals. With regard to LVC training, the current NASMP policy states, "Safety must be an integral part of planning and execution. Live blue (friendly) and red (adversary) platform displays, training mode functionality and training rules must help mitigate safety risks associated with an LVC environment (NASMP Policy IV)." Under the Office of Naval Research (ONR) program, *Virtual and Constructive Representations on Live Avionics Displays* (VCR LAD), researchers are examining the possible effects of introducing LVC into exercises across the Navy air combat training pipeline. To date, this program has focused on the inside of the cockpit and effects on the pilot. In this paper, we turn our attention to impacts the LVC paradigm might have on training exercise management.

This paper presents an exploratory assessment of data collected within the ONR VCR LAD program conducted to gain insight into the possible exercise management implications of using the LVC paradigm in Navy air combat

training. Considerations identified by this effort may aid in the management of future training exercises, from the most basic to the most complex, so that the training successes we experience today are not only preserved, but can be enhanced via the inclusion of new advanced technologies.

METHOD

Participants

An unstructured interview was conducted with one Navy air combat subject matter expert (SME). In addition, semi-structured discussion-style interviews were conducted with seven active duty F/A-18 aircrew, one active duty Air Intercept Controller (AIC), and one reservist Range Training Officer (RTO). The Navy air combat SME had over 2,800 flight hours in Navy air combat jets, including hours as a professional adversary pilot to support training; had been on three deployments; was a qualified RTO; and flew F/A-18s in the Navy Reserves. The SME additionally has 3 yrs of experience working on the LVC air combat training concept. The seven active duty participants were five F/A-18 pilots and two F/A-18 Weapons Systems Operators (WSOs; some F/A-18 models are flown by a pilot supported by a WSO) with an average of 1224.29 flight hours (s=606.46 hrs) in the F/A-18. Details about the AIC and reservist RTO are not provided to protect their anonymity; however, both were described as highly respected experts by their peers.

Data Collection

Three project team members held a 1-hour unstructured telephone interview with the Navy air combat SME for the purpose of obtaining an understanding of F/A-18 training exercise management and, in particular, the roles, responsibilities, and challenges involved. Two team members took notes during the interview and subsequently combined them into a single document. Further contributing to the team's growing understanding of the Navy air combat training domain were two guided tours of the exercise management control center at the Naval Air Warfare Development Center (NAWDC).

Five project team members held discussion-style interviews of approximately one hour (Range: 30 to 90 min) with each of the other participants. At the beginning of each interview, the Navy air combat SME gave an approximately 20-min, in-depth description of the LVC training paradigm and the ways it might be used to support Navy air combat training. After this introductory description, the team members raised a series of potential challenges associated with the implementation of the LVC paradigm for air combat training and the SME discussed each challenge with the interviewee, giving the interviewee time to share his own ideas and concerns and to comment on the SME's ideas and concerns. These nine interviews were conducted in facilities where recording devices are not permitted. Three team members took notes and subsequently combined them into a document. Each set of interview notes was sent to the corresponding interviewee for review.

Data Assessment
A thematic analysis (Braun & Clarke, 2006; Hsieh & Shannon, 2005) of the data was performed. All interviews were culled for information related to changes and challenges that the LVC paradigm might introduce into training exercise management. Excerpts in the culled set were categorized by theme using a data-driven approach; that is, each was given a label that referenced the change or challenge to which it related, and as similar labels began to emerge, groups of similarly labeled excerpts were formed and given a new label that captured the range of variety within their group. Thus, for example, excerpts related to RTO workload were all grouped together. Within that group, subgroups of excerpts were formed to capture more specific workload themes; for example, excerpts about workload produced by the real-time adaptation of constructive entities, workload related to the complexity of the exercise, and workload management strategies. Information obtained in the unstructured interview was additionally used to give the project team an understanding of how exercise management is performed in complex Naval air combat training events.

RESULTS and DISCUSSION

First, to help the reader understand the challenges LVC training could pose to exercise management operations, interview data relating current operations are described. Then, following this overview, we present possible challenges and solutions also derived from interview data.

Overview of Training Exercise Management

The central role in Naval air combat training exercise management is that of the RTO. Depending on the complexity of an exercise, there can be anywhere from two to four RTOs, and some squadrons may add a Range Safety Officer (RSO) to the staff for the most complex exercises. In a very complex exercise, the requisite "red" RTO and "blue" RTO will be accompanied by a command-and-control (C2) RTO and an enemy Integrated Air Defense System (IADS) RTO. The red and blue RTOs are responsible for coordinating the adversary and training aircrew, respectively. The C2 RTO is responsible for supporting the officers who serve as air traffic controllers from the back of the E-2. The IADS RTO sits adjacent to the red RTO and manages the behavior of simulated enemy Surface-to-Air Missile (SAM) sites and short-notice enemy aircraft launches. The RSO, if included, assumes overarching responsibility for safety. When present he or she will speak directly to the aircrew if there is a safety issue to rectify. If the aircrew hear the voice of the RSO, they immediately know actions need to be taken to ensure safety. There is additionally a role that involves overseeing the entire event. This role may be performed by the IADS RTO, who is also called the IADS Commander, or by a person designated as the Overall Instructor.

Even when an RSO is included, safety is the responsibility of everyone participating in an integrated training event; from the overall training exercise lead, to those in the exercise management facility, to the aircrew in the cockpit (including the adversary pilots). The main mechanism used to maintain safety is a set of established live-flight training rules that are well-known and briefed (as a reminder) to all participating individuals. One example of a training rule is the use of altitude blocks, where event participants and adversary pilots are required to stay within different altitude blocks when they are within 10 nm of each other. Other mechanisms used to maintain safety during air combat training are communication phrases that immediately end an engagement or an exercise that someone perceives as becoming unsafe. If a pilot is uncomfortable with his safety during an engagement, he can call "terminate" over the radio to end the engagement. Adversary pilots and exercise management personnel can additionally call "knock it off" to end an exercise.

Currently, the Tactical Support Wing (TSW), which encompasses VFC-12 (Fighter Squadron Composite-12; F/A-18), VFC-111 (F-5), VFC-13 (F-5), and VFA-204 (professional and qualified red air squadrons) all use an RTO, controller and instructor for training events. If the training event is complex, such as a 4v4 or more, or if the event utilizes split frequencies where the blue and red air are on different frequencies, then they all may utilize an RSO. Current operations deem RTOs are capable of handling most training events with the exception of a few that require the addition of an RSO. Typically, there are at least two RTOs for a training event: a blue RTO and red RTO working together. The blue RTO monitors the blue trainees in the air and the red RTO monitors the adversary instructors against which the blue trainees are flying.

In general, RTOs must listen to all the different communication calls from the aircrew and monitor behavior of both the red and blue air crews. Through the use of the Tactical Combat Training System (TCTS), the system that provides data from the aircraft about the event, RTOs are able to monitor "time, space, position and weapon employment information" ("Naval Aviation Training Systems," 2015) during training exercises. There is one type of interface used by the RTOs, RSOs, or exercise management team, within the control center during run time and debrief. This technology allows for the RTO/RSOs to have a god's eye view of the training event in real time; however there is little room for manipulation of the interface that could aid workload and situational awareness. For debrief, this system is able to replay the entire event with controls for the instructor to fast forward and/or rewind to stress specific instances for the aircrew.

Monitoring communication calls from the aircrew can be difficult or cause workload to be high as some calls may overlap and be difficult to hear. As an RTO becomes more experienced, they are able to anticipate certain communications based upon the environment and the behaviors exhibited by the aircrew. Communication is key in and out of the cockpit as the blue RTO must accurately relay what is happening to the red RTO in order for them to relay to the aircrew (the trainees) specific instructions during certain timely situations (e.g., when to kill remove). This communication is critical for safety as kill removing involves exiting the training scenario without causing any disruption or crossing paths with others. A primary way to ensure safety of flight and maintain separation between red and blue air is the use of altitude blocks, as previously explained. These blocks are briefed beforehand and are written in the aircrew's kneeboard that is attached to the pilot containing important flight data and provides the ability to take notes pertaining to the training exercise. It is the responsibility of everyone to maintain altitude

within their assigned block; however, the RTO monitors airspeed and altitudes to ensure rules are followed. Current operations require a high level of situational awareness, and result in significant workload to maintain safety and meet training objectives.

Blue RTOs also monitor and track shots taken by the aircrew to determine if they are successful. This aids the realism of the training event to ensure the aircrew meet established training objectives and behave realistically within the rules of the training event. Coordination between the RTO, RSO, the IADS commander, ground engagements, and the overall event instructor is critical to maintain this realism.

The aircrew, both blue and red, are expected to execute the kneeboard cards that contains the briefed plan for the event. However, deviations may need to occur for multiple reasons and thus must be closely monitored and noted by the RTO to maintain safety and to include in debrief.

Upon returning from the training event, the red aircrew will meet with the overall event instructor in order to compare timelines and ensure all objectives were noted. The aircrew then enters a debrief led by the lead instructor using the TCTS data for replay. Debriefs are discussion based, with all communities providing input into constructing the timeline of the event.

Potential Changes and Challenges

The question addressed in this research was whether the inclusion of LVC training would have an effect on the current operations of the RTO, and possibly the RSO, in regards to managing safety. A number of ways the LVC training paradigm could impact the work of exercise management were derived from the interviews. These potential impacts are described below.

LVC System Status Management and Communication

Maintaining situation awareness in air combat depends on the anticipation, recognition, and comprehension of significant changes, including artificial changes such as those produced by exercise management turning the LVC system on or off during a training exercise. The LVC system includes injecting virtual and constructive entities into live aircraft displays. Allowing control to essentially clear the displays of virtual and constructive tracks is a possible technique to aid safety. However, surprise changes in the environment can distract exercise participants at times when their focused attention is critical, potentially resulting in an unsafe situation. As mitigation to such situations, any participant, adversary pilot, or exercise manager can call for the termination of an engagement or exercise by calling "terminate" or "knock it off", respectively. Nevertheless, safety may be further preserved by providing exercise management with procedures or technologies for informing exercise participants when they are about to make a change to the system status (i.e., when they turn the LVC system off) or when the system shuts down accidentally.

On the flip side, exercise participants may have the ability to shut down the LVC system locally, in their own cockpits. According to one interviewee, exercise management may want to keep track of the on-off status of the LVC system in each cockpit so they know what each aircrew is seeing. Knowing whether the system has been turned off in individual cockpits allows exercise management to detect when workload may be getting high, to confirm that an aircrew has turned off the system when exiting the exercise early or kill removing, and to know whether or not the aircrew are being exposed to the full training experience. The provision of this information to management should be optional, based on the exercise manager's preferences, and will also need to be communicated in a way that integrates well into an already information-intensive work environment; for example, possibly as a tag on displayed aircraft tracks.

Real-Time Changes to the Adversary Plan

The addition of constructive adversaries complicates the process of making real-time changes to, or deviations in, the adversary game plan. Currently, real-time changes are made to the adversary game plan by both exercise management and the adversary pilots in order to be responsive to the tactics, mistakes, and performance level of the training exercise participants. Interviewees said adversaries would deviate from the plan in real time in order to, for example, "punish mistakes" or scale back a game plan that seems too advanced for the friendly air participants. With the introduction of the LVC paradigm, these deviations likely will need to be coordinated with someone responsible for controlling the constructive adversaries, and the controls for those adversaries will need to have a design that

makes it possible to very quickly adjust the behavior of potentially larger numbers of adversaries and then to quickly re-adjust as necessary. Very possibly, the person responsible for controlling the constructive adversaries will not be the RTO or any other existing role; instead, a new role for managing constructive entities, under the RTO's direction, may need to be defined.

Within-Visual-Range (WVR) Combat with Virtual and Constructive Aircraft
If, in a given exercise, virtual and constructive aircraft are allowed to go to the merge (i.e., to enter into close-quarters combat with live aircraft), exercise management may have additional responsibilities. There may be an increase in the variety of safety risks exercise management needs to be able to detect, depending on how the paradigm is employed. For example, if aircrew cannot tell whether a track with which they are about to merge is live or not, there is a risk that they will spend too much time searching the surrounding airspace through the cockpit window and lose their situation awareness. There is also a potential for an aircraft's targeting radar to accidentally lock on to a constructive track instead of its intended live wingman, in which case the pilot may tunnel her attention on trying to find a nonexistent aircraft in her display's targeting box (a large area for research). Consequently, exercise management personnel may have more types of problems to be aware of and may have to intervene more often. The RTO additionally may be expected to tell each aircrew the number of live adversaries or the numbers of both live and non-live adversaries going to the merge with them. RTOs currently will sometimes call the number of adversaries going to a merge during training exercises. This practice, or a version of it in which the RTO calls the number of virtual and constructive aircraft (e.g., "Merging with one diggie and one live.") or the number of live aircraft, may become routine for LVC exercises in which virtual and constructive aircraft go to the merge, especially if their tracks are not distinguished from live aircraft tracks by any sort of marker.

Whether virtual and constructive aircraft will be allowed to go the merge remains to be resolved, as there currently are concerns about both safety and negative impacts on training. Nevertheless, even if they are not allowed, exercise managers may still have new responsibilities; these would be associated with keeping the virtual and constructive adversaries out of the WVR arena (i.e., more than about 10 miles away from any friendly aircraft). Exercise management personnel might be responsible for detecting any virtual or constructive aircraft that accidentally cross that distance threshold. In addition, monitoring the adversary game plan may become more complicated. The adversary game plan will likely play a central role in preventing virtual and constructive aircraft from entering the WVR arena; it may, for example, call for all virtual and constructive aircraft to be shot down or to turn around and "run away" before reaching the WVR distance threshold. There may even be a point in the plan where a constructive aircraft is replaced by a live aircraft in order to take advantage of the Beyond-Visual-Range (BVR) features the constructive aircraft can offer along with the WVR benefits of live aircraft. In this case, the RTO may also help ensure that the game plan unfolds and adapts in realistic ways while ensuring the virtual and constructive aircraft do not pass the threshold from BVR to WVR.

Ensuring Enforcement of Training Rules
An important role of exercise management is the detection of training rule violations. For example, RTOs check the altitude and speed of aircraft to make sure they stay within specified limits, and they monitor for the crossing of range space boundaries. When the LVC paradigm is introduced into live air combat training, the strategies and routines RTOs use to detect training rule violations may be impacted. For example, an RTO we interviewed described checking each adversary aircraft's altitude in turn as he gave each aircraft's crew an update on the bearing, range, and altitude of the friendly fighters. He realized he might not detect training rule violations by constructive aircraft because he would not be giving them individual picture updates and consequently would not be checking on them.

Although constructive aircraft do not represent real collision threats, exercise participants will not necessarily be able to distinguish them from other types of aircraft, as their displayed tracks will likely not be marked as constructive. Consequently, an aircrew might maneuver in response to a constructive aircraft that has crossed into their altitude block, and that maneuvering would be unsafe if done in close proximity to a wingman.

Kill Removal
In live training exercises, kill removal has traditionally involved a live aircraft flying from a central part of the exercise airspace to its outskirts immediately after the RTO declares that the aircraft has been shot. The aircraft is designated as a kill by someone overseeing the exercise, the pilot is informed, and, fuel permitting, the aircraft immediately flies down to the lowest altitude of the designated exercise airspace and heads directly toward the

airspace border. With the introduction of the LVC paradigm, however, kill removal may not always happen in that way. It will be possible to simply make virtual and constructive aircraft disappear and there will be no need for them to transit the airspace during the kill removal process.

Although the ability to disappear when shot has safety benefits, it may also be a source of confusion. Specifically, because aircraft kill remove in different ways, exercise participants may mistakenly think a killed aircraft is constructive and get caught by surprise by a live aircraft kill removing through the exercise airspace. Future test and evaluation trials will shed light on whether or not this will be a real issue; if it is, the RTO may need to inform at least command-and-control exercise participants of the type of aircraft. The RTO may additionally have the responsibility of ensuring a kill removing aircraft has decluttered displays of the virtual and constructive tracks.

Handling Complexity
LVC training exercises have the potential to be much more complex than current live training exercises. Compared to traditional training exercises, LVC exercises will feature greater numbers of adversaries, a wider variety of entities (virtual and constructive in addition to live), and simulated adversaries with more sophisticated weapons and sensor systems. This translates into more moving parts and a greater potential for unexpected interactions among those moving parts. Some of the associated exercise management work is captured in the paragraphs above, but the potential exists for much more and greater variety of work to emerge than what is considered in this paper.

In addition to this increase in the variety of safety concerns within the exercise, exercise management will have new coordination responsibilities. They will need to oversee the coordination among a distributed team of pilots flying live aircraft, pilots flying simulators (virtual), and computer-generated aircraft (constructive). This coordination may include ensuring all three groups contribute to or participate in the exercise brief and debrief, and they may also have to apprise virtual pilots and the person controlling the constructive aircraft about elements of the live world that are absent from their representations of that world (e.g., weather).

IMPLICATIONS and RECOMMENDATIONS

The RTO has traditionally had responsibility for the entire blue and red piece of an exercise. Along with that responsibility, this position keeps track of the other side's entities (red or blue, respectively) in order to effectively oversee the responsiveness of his charges to the other side's tactics. He or she likewise monitors the airspace and communications for changes that may require a response or adaptation. In other words, each RTO keeps track of almost all aspects of the airspace and exercise in order to effectively oversee and ensure the safety of the entities assigned to him or her.

The potential impacts of LVC training described above suggest that exercise management will face new responsibilities that will add to their existing communication, coordination, control, and monitoring work. It could be tempting to reduce the RTO's workload during complex LVC exercises by off-loading control of the entities or tasks for which the RTO is responsible. More specifically, squadrons will sometimes add an RSO or RTO assistant to the exercise management staff of large, complex exercises. These mechanisms also include standard communications such as the communication "north group vanished," which could be used to communicate that a group of virtual or constructive entities had been removed from an exercise, to prevent virtual and constructive entities from entering the merge, or to scale back an exercise's difficulty level. The entities and tasks are all intertwined, however, and so taking any one of them away from the RTO could produce a gap in the RTO's situation awareness or negatively impact the ability to effectively manage or control the exercise. Doing so could even add, instead of decrease, workload if the RTO ends up monitoring or interacting with the person or technology to which the entity or task was offloaded. A new role or technology could be more disruptive than helpful as with adding or deleting aspects within complex systems may result in ripple effects.

One specific addition could be additional personnel to monitor the constructive entities. As stated in the NASMP IV policy, "The Red Forces Director will operate the NGTS/Joint SAF system real time during an exercise to maintain timelines and ensure the authenticity of the threat system is replicated. This position will run the threat and white presentations for all sites during the exercise." This has the potential to be a critical position as the fidelity of SAF technology today, while increasing, sometimes requires increased intervention and/or monitoring by instructors (Pagan, Kaste, Reni, Sciarini, & Walwanis, 2013). However, this policy should be empirically investigated to establish the specific tasks and responsibilities for this addition. As with current operations, the inclusion of another

personnel to run the virtual and constructive tracks may be dependent upon the specific training event and level of complexity. If given the ability to manipulate, the current RTO may be able to control the virtual and constructive entities if he or she has the bandwidth (e.g., an event less complex than a 4v4).

To the extent possible, additions to exercise management should assist the RTO with maintaining situation awareness and control, rather than usurp RTO responsibilities. The experienced human is better able than computer software to detect and respond to changes in a fast-paced, variable, dynamic, and complex environment in which all possible interactions cannot be fully known in advance; and the more experienced the human is, the greater his advantage over a technology solution. Consequently, the experienced human should be supported while maintaining full control of the exercise management work. The form of this support will need to be evolved and adapted as the LVC paradigm begins to be implemented.

Other support suggestions from interviewees consisted of user interface design concepts that directly support a variety of strategies used commonly by RTOs to monitor and interact with exercise entities. As stated before, the interface with TCTS data provides information to populate a god's-eye-view of the training event in real time for the control station, with little manipulation available. The inclusion of LVC training may require more user interface manipulation in order for the RTO to not only be able to monitor all of the entities – live, virtual and constructive – but to also be able to effectively manipulate the constructive entities to aid training. Two interviewees described a display with intuitive controls that would integrate with existing user practices. One interviewee described, "[touches left side of imaginary screen] Track 1, [touches again to the right] Beam, [touches further to the right], North."

Another suggestion is the development of work-support tools, such as tools that detect and alert the RTO about training rule violations and tools that give the RTO control over exercise complexity. These sort of support tools have the potential to aid RTO responsibility now and thus also in the future with the LVC paradigm.

The third common suggestion was to activate exercise management roles such as the RSO and RTO assistant to assist with the increased complexity and variety of LVC exercises. In general, the more of these support options available to exercise management, the better exercise management will be able to adapt their management strategies to the specifics of a given exercise and exercise management team.

CONCLUSION

The considerations presented here are derived from interview data with multiple SMEs. Analyses provided areas of concurrence, and as such, was the foundation for the possible management considerations provided.

It is likely that, in addition to the co-opting and adaptation of existing mechanisms, new procedures, technology solutions, and organizational changes will be needed. Additions to the complex and established system of exercise management pose risks, some of which are noted above. Despite efforts to identify and address additional risks, their potential interactions with the existing training system are many and impossible to fully anticipate or know. Consequently, we recommend the gradual, iterative design and introduction of solutions so they have the opportunity to gradually adapt to the complex established system and vice versa.

Additionally, future research is necessary to determine the effects of the inclusion of LVC into integrated training events. Baseline workload and situational awareness needs to be established through the use of situational awareness tests (e.g., Situation-Awareness Global Assessment Technique (SAGAT), Situational Awareness Linked Instances Adapted to Novel Tasks (SALIANT)) (Endsley, 1998; Muñiz, Stout, Bowers & Salas, 1998). This could later be used to aid development of user interfaces for RTO/RSO use. Another area of research is to validate the considerations provided here through empirical investigation. This could include studies on interface design, attention allocation, symbology effects, workload, situational awareness, task load distribution and personnel.

ACKNOWLEDGEMENT

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