Joint Terminal Attack Controller-Training Rehearsal System: Competency-based Research

1Lt. Sean A. Morris, Dr. Christine M. Covas-Smith, Leah J. Rowe
Air Force Research Laboratory
Wright Patterson Air Force Base, OH
Sean.Morris@us.af.mil,
Christine.Covas-Smith@us.af.mil
Leah.Rowe.1@us.af.mil

Christina L. Kunkle, Keith W. Westheimer
Leidos, Inc.
Dayton, OH
Christina.Kunkle.ctr@us.af.mil,
Keith.Westheimer.ctr@us.af.mil

ABSTRACT

The Joint Terminal Attack Controller (JTAC) warfighter is responsible for supporting the Army Maneuver commanders by controlling aircraft and weapons employment in Close Air Support (CAS) environments. JTACs are typically co-located with Army units, however, they are required to communicate and collaborate with a number of personnel operating external to their locations. JTACs are required to maintain a significant level of proficiency by regularly training in both live and simulation environments. Due to increasing reductions of aircraft to aide in live training events and limitations in simulator technology, trainings gaps have arisen that hinder the opportunities for JTACs to achieve required levels of proficiency. This paper will introduce an ongoing effort to create a robust JTAC training environment – the Joint Terminal Attack Controller-Training Rehearsal System (JTAC-TRS). The JTAC training gaps are being assessed and explored within the JTAC-TRS using problem-based learning approaches by analyzing the Mission Essential Competencies[SM] (MEC). Using MECs, we have identified the primary and supporting competencies, knowledge, skills, and developmental experiences that a JTAC must have to effectively execute the mission. Preliminary evaluations of this system demonstrate that the JTAC-TRS has reduced 50% of these training gaps. We will present data regarding the identified training gaps and how they are addressed in this unique training environment.

ABOUT THE AUTHORS

1st Lt Sean A. Morris is the Program Manager for Joint Terminal Attack Controller systems and Lead Engineer for Air Support Operations Center systems in the Continuous Learning Branch in the Warfighter Readiness Research Division at the Air Force Research Laboratory. Lt Morris holds a B.S. in Electrical Engineering and is presently pursuing a Master of Business Administration degree.

Dr. Christine M. Covas-Smith is a Research Psychologist in the Continuous Learning and Performance Assessment Branch in the Warfighter Readiness Research Division at the Air Force Research Laboratory. She is a researcher for the Integrated Combat Operations Training-Research Testbed for Unmanned Aerial Systems and Joint Terminal Attack Controller systems. She is also Government Lead for the Intuitive Decision Making Lab. She holds a Ph.D. in Psychology and a M.S. in Applied Psychology from Arizona State University. Her research interests include training, metrics and methods, decision making, perception and cognition.

Ms. Christina L. Kunkle is the Contractor Research Lead for JTAC and researcher in the Intuitive Decision Making Lab in the Warfighter Readiness Research Division at Air Force Research Laboratory. She holds a M.A. in Experimental Psychology and research interests include decision making, training, human factors aviation, and eye tracking.

Mr. Keith Westheimer is the Senior Joint Close Air Support (JCAS) Operations and Training Expert for Leidos Corporation at the Warfighter Readiness Research Division at the Air Force Research Laboratory. He has 16 years experience in Close Air Support (CAS) operations as both a combat operator and training/evaluation program manager, as well as extensive testing in the area of Close Air Support simulations/digital warfare, Command and Control, and Distributed Mission Operations. He is responsible for assisting research teams in the area of human

effectiveness regarding CAS training via simulations, to include research/training scenario and syllabus development, validation/implementation of current military Tactics, Techniques and Procedures (TTP) in simulations, training effectiveness measurement tools, and refinement of digital equipment interfaces involved in CAS simulations. He provides JTAC-centric perspective as a Subject Matter Expert (SME) to other AFRL team members to support/develop their programs/projects within the ICOTT training/research program. He holds a B.S. from University of North Texas, and has extensive experience at all echelons of CAS-related military units, from tactical-level Company/Battalion/Brigade operations to strategic-level Air Support Operations Center (ASOC) and Combined Air Operations Centers (CAOC).

Ms. Leah J. Rowe is the Technical Advisor for the Continuous Learning and Performance Assessment Branch in the Warfighter Readiness Research Division at the Air Force Research Laboratory. She is the principal for the Integrated Combat Operations Training-Research Testbed where she leads researchers, engineers, and subject matter experts in the development of an operationally rich training research environment. Ms. Rowe is the Program Manager for Unmanned Aerial Systems, Air Support Operation Center, and Coalition Mission Training efforts. She holds a M.S. in Applied Psychology and is presently pursing a doctorate degree in Industrial/Organizational Psychology. Her research interests include training, metrics and methods, instructional design theory, knowledge acquisition, team training, and performance measurement.

Joint Terminal Attack Controller-Training Rehearsal System: Competency-based Research

1Lt. Sean Morris, Dr. Christine M. Covas-Smith
Leah J. Rowe
Air Force Research Laboratory
Wright Patterson Air Force Base, OH
Sean.Morris@us.af.mil, Christine Covas-Smith@us.af.mil
Leah.Rowe.1@us.af.mil

Christine L. Kunkle,
Keith W. Westheimer
Leidos, Inc.
Dayton, OH
Christina.Kunkle.ctr@us.af.mil
Keith.Westheimer.ctr@us.af.mil

INTRODUCTION

The Air Force Joint Terminal Attack Controller (JTAC) is a Tactical Air Control Party (TACP) warfighter who is qualified to coordinate and employ ordinance effects in close proximity of friendly personnel in Close Air Support (CAS) environments. JTACS are responsible for the airspace in a given area of operations. Their task consists of identifying and calling out targets and locations for the aircraft that they are coordinating. The majority of JTAC tasks are completed using verbal communication and some chat-based communication. The JTAC carries out the intent of Army Maneuver Commanders by controlling the maneuvering of air and artillery assets; "He is the link between the fielded forces and the supporting air assets" (AFTTP 3-3.JTAC, 2010). JTACs operate in a variety of complex combat environments such as urban settings where the potential to cause unintended harm on civilian and other non-combatant targets are high. To decrease the likelihood of this harm, JTACs must have expert knowledge regarding the lethality of weapons effects and which air or artillery assets can provide them. JTAC's must also be highly proficient as to information management on a battlefield setting for CAS missions.

JTAC training has become much more challenging to accomplish on live ranges due to increasing restrictions on live-fly time for supporting aircraft such as A-10, F-16 and Remotely Piloted Aircraft (RPA). The Joint Terminal Attack Controller Training Rehearsal System (JTAC-TRS) at the Air Force Research Laboratory is training simulator accredited by the Joint Fire Support Executive Steering Committee (JFS ESC) to replace two out of six live controlled training exercises or controls every six months. Simulation becomes even more valuable in the current fiscal environment, as many of these assets are difficult to provide in a real-world environment due to the cost of live-fly aircraft and coordination with other live assets. Simulated training provides a unique opportunity for JTACs. Simulated training can provide both the critical and expensive live assets that are difficult to include in the real-world, as well as a host of other white and red force players for the JTACs to interact with in training. Thus, simulated training environments provide training opportunities for JTACS that are difficult to replicate in a typical live-range training event.

There are multiple JTAC training systems available including the Call for Fire Trainer (CFFT), the Enhanced Indirect Fires-Forward Air Control Trainer (E-IFACT), the Joint Fires and Effects Trainer System (JFETS), the Multipurpose Supporting Arms Trainer (MSAT), and the Air National Guard Advanced Joint Terminal Attack Controller Training System (AAJTS). Although these training systems provide the ability to rehearse some aspects of the JTAC domain and mission areas, they have not been assessed as to their training value and ability to develop and improve mission essential knowledge, skills and abilities. Thus, the goal of the current evaluation is multifold. We aspired to assess the JTAC-TRS to determine 1) what are the best tasks to train in a JTAC simulator, 2) whether or not we can support the development of mission essential knowledge, skills and abilities for these key warfighters and 3) whether or not the JTAC-TRS can provide them with controls that they can use in place of live-range training exercises. We also sought to determine which identified training gaps can be mitigated by using the JTAC-TRS and to what extent does the system satisfy the current training need. The training gaps that were identified by the MEC analysis included supporting a military operations on urban terrain (MOUT) mission, combat experience, working with joint and coalition forces, immediate action drill, control in different environments, rotary wing Close Combat Attack (CCA) / Close Air Support (CAS), have conducted observed joint fired, and working with a variety of systems.

The Warfighter Readiness Research Division (711 HPW/RHA) at the Air Force Research Laboratory has been performing training effectiveness and readiness research for over 35 years (Genter, Tiller, Cunningham, & Bennett, 1999; Rowe, Prost, Schreiber & Bennett, 2008; Colegrove, Rowe, Alliger, Garrity, & Bennett, 2009; Schreiber & Bennett, 2011; Alliger, Beard, Bennett, Symons & Colegrove, 2013). The goal of the current evaluation is to take this vetted approach to training Mission Essential Competencies (MECs^{SM}) and apply it to the JTAC domain. Mission Essential Competencies represent the higher-order individual, team and inter-team knowledge, skills and experiences that a fully prepared team requires in order to enable successful mission completion under adverse conditions and in a non-permissive environment (Colegrove & Alliger, 2002). As one component of the MEC process, subject matter experts (SMEs) generate a list of critical mission experiences in which a warfighter must be competent before considered as being prepared for a mission. MECS, as used in the current context, are especially useful in identifying the gaps that need to be addressed in current training systems. The initial JTAC gaps identified from the pre-training and post-training experiences will be assessed here as a measure of what MEC gaps the JTAC-TRS is addressing and what gaps remain to be addressed.

The JTAC evaluation measures were modeled using the MEC process approximating the measures used in previous F-16, Distributed Mission Operations (DMO) training research (e.g., Schreiber & Bennett, 2006). Measures include both objective and subjective measures of skill-based learning, self-reported learning, reactions and overall assessments of the JTAC-TRS capabilities. Each team completes two benchmark scenarios at the beginning and end of an evaluation week. The benchmark scenarios enable performance to be measured both subjectively with observation forms and objectively in real-time through our in-house Performance Evaluation Tracking System (PETS) which sits on the network and monitors Distributed Interactive System (DIS) packets to collect performance-based measures (Neubauer & Watz, 2011; Watz, Keck, & Schreiber 2004; Schreiber, Watz, Bennett, & Portrey, 2003a & b). Verbal team communication and coordination are recorded by a PETS Event Logger which captures activities like check-ins, 9 lines, attack clearances, etc. The goal of the current evaluation is to assess the JTAC-TRS and its associated research tools and metrics to determine whether we can create positive training and enable training research data collection while providing much needed replacement of live training controls to our Warfighters.

METHOD

Participants

Thirty-eight JTACS and Radio Operator, Maintainer And Driver (ROMADS; 23 JTACS and 15 ROMADs, mean age 25.6 years) participated in the evaluation. ROMADS are the next generation of JTACs, they aid current JTACs in the field and are working to qualify to earn their JTAC status. All participants were active duty and had an average of 5.8 years of service, 2.6 years experience, and 141.50 controls. The majority of participants reported using a simulator for previous training including the Call for Fire Trainer (CFFT), Enhanced Indirect Fires-Forward Air Control Trainer (E-IFACT), Joint Fires and Effects Trainer System (JFETS), and the Multipurpose Supporting Arms Trainer (MSAT). The majority of participants also report having participated in recent events and exercises the most common include Atlantic Strike and Green Flag East, Joint Readiness Training Center (JRTC).

Stimuli and Apparatus

The JTAC-TRS is a 5 meter, 220^{o} Field of View (FOV) simulator developed by Mersive, which allows JTACs to conduct types I, II, and III daytime controls with target designator capability. The dome has 14 Digital Projection iVision sx+ DLP projectors combined using Scalable Displays Easy Blend interface with MetaVR Virtual Reality Scene Generator (VRSG) for real-time warp blending. The JTAC-TRS is fully equipped with form-fit replica devices (Minerva Engineering) including the Mark VII laser range finder, M-22 binoculars, and Guided Laser Tracking Device (GLTD). The devices are tracked and interfaced with InterSense SONOPODS Inertial Tracking Systems. The 711 HPW/RHA developed eXpert Common Immersive Theater Environment (XCITE) and Battlespace Simulation Incorporated's Modern Air Combat Environment (MACE); which are used for scenario development and execution. Both XCITE and MACE are integrated with VRSG Image Generation software for terrain database and features display. JTAC-TRS uses a radio-bridge capability created by Advanced Simulation Technology Incorporated (ASTi) connected to PRC-11F radios and integrated with Distributed Mission Operations/Live Virtual Constructive (DMO/LVC) environments, along with integrated JTAC mission tools for mission rehearsal and execution. The system provides a simulated Remotely Piloted Aircraft Full-Motion Video

(RPA FMV) feed through Panasonic Tough Books using a Multiple Unified Simulation Environment/Air Force Synthetic Environment for Reconnaissance and Surveillance (MUSE/AFSERS) simulated Unmanned Aerial Vehicle (UAV) camera. JTAC-TRS has a world-wide database capability; which includes coverage for all CONUS locations, Southwest Asia, Germany and Alaska at imagery resolutions of 50-100 cm. The JTAC-TRS also includes an after-action review/debrief system for JTAC instructors and trainees to view the entire battle space, a VRSG stealth viewer channel to see any entity's viewpoint, and the ASTi radio communications.

Figure 1. Evaluation Participants in the Joint Terminal Attack Controller Training Research System (JTAC-TRS). Also shown in the figure are the simulated Remotely Operated Video Enhanced Receiver (ROVER) Feed, the simulated binoculars and the GLTD.

Procedure

Evaluation weeks are scheduled for five days. On the first afternoon, each team (JTAC, TACP) receives an in-brief which includes information about the objectives and a brief overview of the four-day evaluation. Individuals then completed pre-evaluation surveys consisting of a demographic survey, initial readiness assessment and expectations. All participants are provided with an example scenario packet to familiarize themselves with the layout and type of information that they would have available for mission planning. The scenario packets include a mission brief, map insets of the scenario area, artillery targeting worksheet and a target reference point (TRP) pre-planning worksheet. Teams then completed a familiarization scenario to become familiar with the simulator and the tools provided to them including a demonstration of the after-action review/debrief system and capabilities. On the benchmark days of the evaluation (generally Tuesday and Friday), each team completes two randomly-assigned thirty-minute defensive and offensive benchmark scenarios. Before beginning each benchmark scenario, each team is given thirty minutes for mission planning and provided with a mission packet including a mission brief and maps. Teams are allowed fifteen minutes in the dome to prepare and set up the equipment. Following the first benchmark session, teams are encouraged to take a break before starting mission planning for the second benchmark. Once both benchmarks are completed, teams are allowed to debrief both of the benchmark scenarios.

During the non-benchmark days, teams complete up to two scenarios of their choice per day, typically completing six non-benchmark scenarios during the course of a week. Like the benchmark scenarios, each of these scenarios is preceded by half-an-hour of mission planning and up to fifteen minutes of in-dome preparation. Each mission is then followed by an hour of debrief. On Thursday afternoon, each participant completes the post-evaluation surveys consisting of 1) reactions to the evaluation, 2) follow-up readiness, 3) experiences and 4) JTAC-TRS capability surveys. Data collected during the evaluation weeks included skill-based measures of learning, self-reported learning, reactions to training, and a JTAC-TRS Capabilities Assessment. Each of these will be discussed in turn below.

Skill-based measures of learning

The JTAC research testbed relies on skill-based measures of learning to evaluate the impact of the training methods and scenarios/syllabi. The outcomes of each team's performance on the two benchmarks completed at the beginning and the end of the training week were computed for both subjective and observation-based metrics as well as real-time performance based metrics. The benchmark scenarios are designed to be difficult and to present the same set of data points that will be measured across the week. These data points enable us to measure the level of readiness when teams arrive and the level of readiness when they depart. Within the benchmark, participants are observationally measured on whether or not the surface-to-air threat was neutralized, the number of friendly aircraft shot down, the number of successful and unsuccessful aircraft attacks, the number of artillery attacks, the number of enemy ground vehicles neutralized, the number of ground friendly mortalities and fratricides, whether or not phase lines are breached (defensive only), whether or not the JTAC was disabled and whether or not the benchmark was completed in the thirty-minute time frame. Participants are also measured as to whether or not they had the ground commander's clearance before both attack and danger-close weapons employment (utilization of weapons within close-range of friendly troops).

Performance-based metrics are also collected by PETS which include entities, time between aircraft check-in and first bomb drop, number of friendly fratricides, number of friendly air-launched bombs dropped, number of ground-launched artillery, blue team entity that came the closest to a threat entity, teams that are closest to the 2-D and 3-D ranges to any threat of the opposing force, and time from the first to the last ultra high frequency (UHF) transmission. Although PETS provides an objective measure of performance, these measures rely on real-time entity states to objectively measure team performance, whereas a JTAC team typically remains in the same geographical location. For JTAC teams, their performance is highly dependent on their communications and coordination with other scenario assets, which cannot be captured by PETS or on a researcher's observation forms. PETS cannot measure the communication between the JTAC, ROMAD, and scenario assets (e.g., the ground commander, aircraft, etc.). The PETS Event Logger has been developed to capture this rich data set. Measures captured by this tool include aircraft check-ins, area of operation (AO) updates, target talk-ons (TTOs), call for fire (CFF) requests, execution orders and end of mission, 9-lines and 5-lines, attack clearances, and battle damage assessments (BDAs).

Self-reported learning

JTACs and ROMADs fill out an initial readiness survey on Monday which asks them to indicate their perceived readiness to perform each of the MEC experiences. On Thursday, participants fill out the Follow-up Readiness survey which asks them the same questions. These two measurement points enable us to examine changes in readiness as a result of their experiences in the evaluation.

Reactions to the Evaluation

JTAC Reactions to the evaluation were captured using an Expectations and Experiences survey and a Reactions survey. The Expectations survey asks participants to rate the extent to which they expect to receive the MEC experiences listed. The Experiences survey asks them to rate the extent to which they received the same MEC experiences. This metric enables the research team to assess whether or not the JTAC training research week is meeting their expectations for specific experiences. The JTAC Reactions survey asks participants to rate the extent to which they agree or disagree with a list of statements pertaining to the skills that they exercised during the research week. The second section asks participants to rate how beneficial the different components of the week are and provides a space for participants to justify/explain their ratings, and the third section contains a list of open ended questions.

RESULTS

Data collected during the evaluation weeks included Skill-based measures of learning, Self-reported learning, and Reactions to training. Each of these will be discussed in turn below. Standard statistics reported (Meyers & Well, 2003) include t-test (*t),* p value (*p),* mean or average *(M),* and standard deviation (*SD*).

Skill-based measures of learning

Teams completed randomly assigned benchmarks on Tuesday and Friday of each evaluation week. For defensive benchmarks, performance did not differ significantly from Tuesday to Friday in the number of successful attacks, unsuccessful attacks, or enemy ground-vehicles neutralized. Additionally, there was not a significant difference in the time that teams took to complete scenarios between Tuesday and Friday, however, with a p value of 0.07 this metric was approaching significance. For offensive benchmarks, teams coordinated significantly more successful attacks on Friday than on Tuesday $t(16) = -3.92$, $p < 0.01$. Team performance approached a significant difference in the increase from Monday to Friday in the number of neutralized enemy ground vehicles, $t(16) = -2.97$, $p = 0.05$, and the decrease in scenario duration on Friday, $t(7) = 2.26$, $p = 0.05$. Overall, there was not a significant change in the number of unsuccessful attacks.

Self-reported learning

Two Pre-Post Readiness surveys asked individuals to rate their current readiness to perform the experiences listed on a scale of 1 ("Not ready") to 5 ("Ready to go"). Data is available for 33 participants. Self-reported readiness changed significantly for five experiences. Specifically, JTACs and ROMADs reported higher levels of readiness on the Follow-up Readiness survey for the following experiences:

- "Take control of multiple restricted operating zones (ROZs) at the same time," $t(15) = -2.49$, $p = 0.03$;
- "Establishing restricted Fire Support Coordinating Measure (FSCMs)", $t(15) = -2.46$, $p = 0.03$;
- " JTAC role in airfield seizure operations", $t(15) = -2.64$, $p = 0.02$;
- "Have conducted observed joint fires", $t(15) = -2.74$, $p = 0.02$; and
- "Setting up equipment", $t(15) = -2.54$, $p = 0.02$.
- "Work with other governmental agencies and non-governmental organizations", $t(15) = 2.21$, $p = 0.04$.

The Expectations survey was given to participants on Monday before they were exposed to the JTAC-TRS. The participants were asked to rate the extent to which they expected to receive the MEC experiences listed. The Experiences survey was given to the participants on Thursday afternoon following the majority of the training week. The Experiences survey asks participants to rate the extent to which they received the same MEC experiences. This metric enables the research team to assess whether or not the JTAC training research week is meeting their expectations for specific experiences. Data is available for 33 participants. JTAC and ROMAD experiences fell significantly below their expectations for the following seven experiences:

- "Setting up drop zones, landing zones, pick up zones," $t(14) = 2.44$, $p = 0.03$;
- "Run airfield/hot landing zone (HLZ) in the absence of other control," $t(13) = 2.48$, $p = 0.03$;
- "Setting up equipment," $t(23) = 4.41$, $p = 0.00$;
- "Digital satellite communications (SATCOM) technology", $t(13) = 3.85$, $p = 0.00$;
- "Command and control (C2) systems," $t(13) = 2.75$, $p = 0.02$;
- "Different cultures and languages," $t(11) = 2.73$, $p = 0.02$; and
- "Operating and maintaining cryptographic devices," $t(14) = 2.75$, $p = 0.02$.

Finally, JTAC and ROMAD experiences significantly exceeded their expectations for the following three experiences:

- "Working with a variety of airframes and weapons systems," $t(31) = -2.48$, $p = 0.03$;
- "Simultaneously operate on multiple nets in AO," $t(31) = -2.99$, $p = 0.01$; and
- "Combat experience," $t(14) = -2.61$, $p = 0.02$.

We compared the data from the Expectations survey and the Experiences survey with known training gaps identified in the initial MEC analysis for JTAC training research. Table 1 depicts the mean score comparison for each of the identified gaps depicted in Figure 2. As shown in Table 1, three out of the eight experiences were statistically significant. Specifically, "Combat experiences", "Have conducted observed joint fires" and "Working with a variety of systems" were all rated as being highly effective in the post-training experiences. Some of the non-significant

differences were already effective according to the ratings, specifically, "Rotary wing CCA/CAS", "Control in different environments", "Working with Joint and Coalition Forces" and "Immediate action drill" were all above the "Effective" rating.

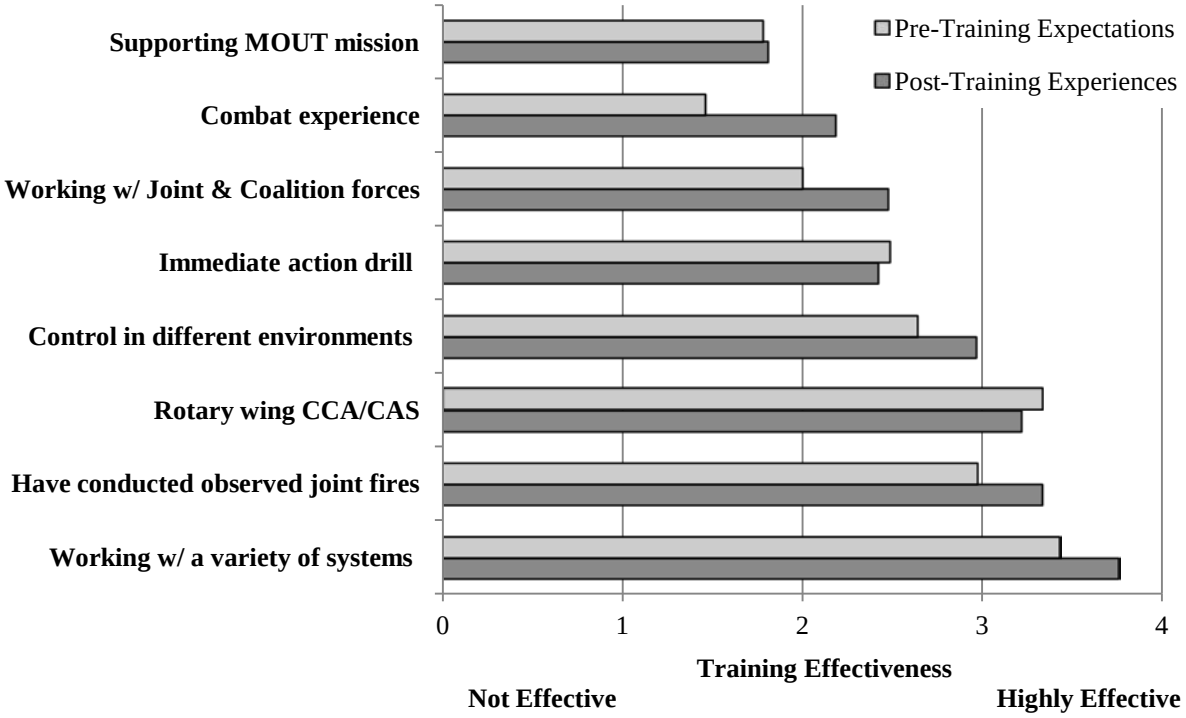

Figure 2. Training Effectiveness ratings for identified training gaps from the Joint Terminal Attack Controller Training Rehearsal System Evaluation. The x-axis depicts the training effectiveness ratings and the y axis depicts the identified training gaps for the Expectations (light gray) and Experiences (dark gray) survey results.

Table 1. Pre-Training Expectations and Post-Training Experiences. Statistical significance of the difference between Pre-Training Expectations and Post-Training Experiences are notated with an asterisk.

Training Gap Description	Pre-Training Expectations	Post-Training Experiences	*t*	*p*
Supporting MOUT mission	1.78	1.81	0.00	1.00
Combat experience	1.46	2.19	-2.61	0.02*
Working w/ Joint & Coalition forces	2.00	2.48	-1.68	0.11
Immediate action drill	2.49	2.42	-0.55	0.59
Control in different environments	2.64	2.97	-1.42	0.17
Rotary wing CCA/CAS	3.33	3.22	0.76	0.46
Have conducted observed joint fires	2.97	3.33	-1.88	0.07*
Working w/ a variety of systems	3.43	3.76	2.68	0.01*

Reactions

Teams completed the Reactions Survey on Thursday afternoons. Reactions survey data is available for thirty-four JTACs and ROMADs. The Reactions survey is comprised of three sections. In the first, participants rated how strongly they agreed or disagreed with a list of statements with a rating of 1 indicating strong disagreement and a 4 indicating strong agreement. JTACs and ROMADs most strongly agreed with the following statements:

- "The training was appropriately paced." $M = 3.22$, $SD = 0.61$;

- "This training event in conjunction with live air-strike control is worthwhile." *M* = 3.69, *SD* = 0.47*;*
- "The scenarios were sequenced in a way that facilitated learning.", *M* = 3.66, *SD* = 0.55*;*
- "The scenarios helped me to effectively meet my learning objective." *M* = 3.59, *SD* = 0.50*;*
- "This training provided excellent experience in air strike control procedures." *M* = 3.50, *SD* = 0.57.

They most strongly disagreed with the following statements:

- "I expected more from this training than was delivered." *M* = 1.91, *SD* = 0.64*;*
- "I can routinely get the type of experience I had at AFRL at my home unit." *M* = 1.75, *SD* = 0.76*;*
- "The scenarios I experienced were unrealistic." *M* = 1.63, *SD* = 0.55*;*
- "I found it difficult to keep up with the pace of the scenarios." *M* = 1.72, *SD* = 0.68*;*
- "The scenarios were not realistic." *M* = 1.63, *SD* = 0.55*;*
- "At my unit, I routinely get to practice air strike against realistic threats." *M* = 1.97, *SD* = 1.04*;*

Overall, from the reactions responses, it seems that JTAC reactions to their training experience at AFRL were favorable.

In the second section, participants were asked to rate how beneficial various components of the week were and provided space to explain their ratings. Ratings were provided on a scale of 1, meaning "Not at all beneficial", to 4, meaning "Extremely beneficial." Ratings range from 2.61 (Briefing Practice) to 3.66 (Debriefing Practice) indicating that overall perceptions are that each of the components listed are beneficial.

In addition to the above ratings, JTACs and ROMADs were also provided space to explain their ratings. In brief, JTAC and ROMAD feedback indicated that there were a good number and type of targets and that these targets were realistic and challenging. For the number of scenarios, they felt that two per day was "perfect" and provided useful practice. JTAC and ROMAD feedback on combat realism was more conflicting; many reported that combat realism cannot be/is hard to simulate, but others felt that the training was realistic. For task saturation, JTACs and ROMADs reported that the scenarios kept them constantly working and thinking and that the task saturation was beneficial. JTAC and ROMAD comments about briefing and debriefing practice indicated that they'd like the ground commander and/or other staff included during mission planning and that the playback of missions and in particular, listening to the missions was beneficial to identifying mistakes. With regard to communications, they felt that it was an opportunity to practice the tactical terminology and that the operation brevity and terminology 3-1 communications were standard. They felt that the dome and particularly the large, 220º field of view were beneficial to building situational awareness. JTACs and ROMADs indicated that the ROE was not always specified or clear and that it could be more detailed. The last set of components that JTACs and ROMADs provided feedback on was for the TTPs for CAS, CFFs, suppression of enemy air defenses (SEAD), and observed artillery fire. For the CAS TTPs, they responded that it was helpful training and used standard TTPs. They also frequently reported that the CFF TTPs were beneficial practice and that they don't practice CFFs enough at their home stations. Finally, JTACs and ROMADs reported that their experiences provided good practice for both SEAD TTPs and observed artillery fire TTPs.

In the third and final section of the reactions survey, participants responded to a number of open-ended questions. The first question asked JTACs and ROMADs to list the top simulation and training environment capabilities of the Integrated Combat Operations Training-Research Testbed (ICOTT). JTACs and ROMADs listed scenarios and debriefs as the top capabilities. Specifically, they responded that the scenarios were realistic and provided excellent practice. Furthermore, they indicated that the scenarios were well developed and presented and were appropriate difficulty levels for varying degrees of experience. The second question required respondents to list the top improvements they would like to see in the simulation and training environment. JTACs and ROMADs stated that improvements could be made to the dome equipment, mission planning, schedule, and the dome visuals. JTACs and ROMADs also listed other platforms that they would like to work with. The top requested platforms to work with were F-16s followed by AC-130s, all fighters, F-18s, helicopters, RPAs, and actual pilots. JTACs and ROMADs were also asked to list other mission types and scenarios they would like to see in the dome. They indicated that they would like to see more scenarios set in Iran and North Korea. Additionally, they would like to see SEAD and AC-130 missions. Next, JTACs and ROMADs were asked to list any training experiences that they wanted or needed to receive but were not getting at their home units. They most frequently responded that there were no other training experiences that they wanted but weren't getting. Other frequent responses were requests for more CAS and more experience with naval gun fire and CFFs. Finally, JTACs and ROMADs were asked to list any overarching training

shortfalls they perceived in their career field that need to be addressed. Most respondents mentioned that training should focus on the quality of graduates produced rather than the quantity.

DISCUSSION

The current evaluation explored whether or not the JTAC-TRS created positive training outcomes for the JTAC warfighters. The use of previously validated methodology including the MEC Expectations and Experiences surveys (Alliger et al., 2013; Alliger et al., 2012; Colegrove & Alliger, 2002; Colegrove et al., 2009; Gentner et al., 1999; Rowe et al., 2008) served as a valuable foundation for the current evaluation. Recall that the current evaluation intended to assess overall training outcomes as well as the tasks and scenarios that are trainable in the current system.

The results of the evaluation clearly demonstrate that our training research program can support the development of mission essential knowledge, skills and abilities for the JTAC warfighters. The use of validated methodology in the MEC process has helped us to demonstrate that the JTAC-TRS can provide valuable training experiences and create positive training outcomes for visiting warfighters. This result is especially valid for the offensive benchmarks, where teams coordinated more successful attacks on Friday than on Tuesday. Scenario duration significantly decreased for offensive benchmark missions on Friday, and the number of neutralized enemy ground vehicles increased. It is important to note that performance in defensive benchmark missions did not differ throughout the week on the number of attacks. These results can be attributed to the types of combat and CAS environments a majority of the JTACs have been exposed to, in which defensive support measures have been the primary means of executing the maneuver commander's intent.

The results suggest that the best tasks to train in a JTAC simulator are 1) rotary wing Close Combat Attack (CCA) / Close Air Support (CAS), 2) conduct observed joint fires, and 3) work with a variety of systems. These tasks had the highest effectiveness ratings out of all of the identified training gaps that JTAC-TRS can support, which are directly correlated to a JTACs primary job of executing the maneuver commander's intent through his role of being the link between ground forces and air assets. These results will be used to refine the scenarios and the benchmark scenarios used at the beginning and end of the week.

The JTAC-TRS is accredited by the Joint Fire Support Executive Steering Committee (JFS ESC) to replace two out of six live controls every six months, which can aide in providing alternatives for replacing mandatory live-fire exercises. These live-fire exercises are important for training in the same ways and environments that the actual job will be performed, but they can be costly in both financial and safety terms. This is why exploring alternative solutions in high-fidelity simulators can be beneficial, and the JFS ESC accreditation provides JTAC commanders the flexibility to train their controllers for weapons employment types I, II, and III. In order for a simulator to be accredited for a type I control without the use of a Head Mounted Display, the screen must span 220 degrees horizontally. This allows enough surface area for a JTAC to turn their heads and see the angle of attack for an air asset, so if need be they can call off the air strike and restructure the attack.

The way ahead for the JTAC-TRS will be to take the results of this initial evaluation and apply it to developing more robust scenarios and increasing overall technological and training fidelity of the system. We strive for system capability to be increased in areas such as automated communication analysis, new devices for the warfighter in the dome and increased artificial intelligence (AI) of the entities that are role players in the scenarios to decrease reliance on Subject Matter Experts (SMEs) to play white and red-force roles. The ultimate goal of the JTAC-TRS is to provide a better than real-world training capability by imparting experiences that are not able to be created in real-world training environments.

CONCLUSION

An important goal of this evaluation was not only to assess performance and the training research tools (scenarios, questionnaires, etc.) but also to illustrate that the JTAC TRS can use the Mission Essential Competencies approach to develop the knowledge, skills, and abilities that are required for the JTACs to perform in the real-world. The results of the current evaluation demonstrate and validate the use of MEC-based and performance-based measurement and training within the JTAC-TRS. Importantly, the results of this initial evaluation direct the tasks that we will focus our future training research towards, namely, rotary wing CCA/CAS, conduct observed joint fires,

and working with a variety of systems. Finally, we will be exploring new technologies and training research tools to increase the capabilities and gaps that can be addressed by the JTAC-TRS in training current and future warfighters.

ACKNOWLEDGEMENTS

The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

REFERENCES

Alliger, G. M., Beard, R., Bennett, W. Jr., Symons, S., & Colegrove, C. M. (2013). *A Psychometric Examination of Mission Essential Competency (MEC) Measures Used in Air Force Distributed Mission Operations Training Needs Analysis*. Military Psychology, 25(3), 218-233.

Alliger, G. M., Beard, R., Bennett, W., & Colegrove, C. M. (2012). Understanding Mission Essential Competencies as a Job Analysis Method. In M. A. Wilson, W. Bennett, S. Gibson, & G. M. Alliger, *The Handbook of Work Analysis Methods, Systems, Applications, and Science of Work Measurement in Organizations* (pp. 603-624). New York: Routledge.

BSI. (2012). http://www.bssim.com/modern_air_combat_environment_mace.html

Colegrove, C. M. & Alliger, G. M. (2002). Mission Essential Competencies: Defining combat mission requirements in a novel way. Paper presented at the *NATO SAS-038 Working Group Meeting*, Brussels, Belgium.

Colegrove, C. M., & Bennett, W. (2006). *Competency-Based Training: Adapting to Warfighter Needs.* Mesa: Air Force Research Laboratory Human Effectiveness Directorate Warfighter Readiness Research Division.

Colegrove, C. M., Rowe, L. J., Alliger, G. M., Garrity, M., & Bennett, W. Jr. (2009). *Defining the Training Mix – Sorties, Sims, and Distributed Mission Operations.* For *2009 Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) Proceedings.* Orlando, FL: National Security Industrial Association.

Genter, F. C., Tiller, T. C., Cunningham, P. H., Bennett, W. Jr. (1999). Using Mission Essential MOEs/MOPs for Evaluating Effectiveness of Distributed Mission Training. In *1999 Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) Proceedings*. Orlando, FL: National Security Industrial Association.

Meyers, J.L. & Well, A.D. (2003). *Research design and statistical analysis*. 2nd Ed. Lawrence Erlbaum Associates, Inc.;Mahwah, NJ.

Neubauer, P., & Watz, E. (2011). *Network Protocol Extensions for Automated Human Performance Assessment in Distributed Training Simulation* (11S-SIW-053). Paper presented to 2011 Spring Simulation Interoperability Workshop, Boston, MA.

Reigeluth, M. M. (1999). *Instructional-Design Theories and Models: A New Paradigm of Instructional Theory* (Vol. II). Mahwah: Lawrence Erlbaum Associates, Publishers.

Rowe, L. J., Prost, J. H., Schreiber, B.T., & Bennett, W. Jr. (2008). Assessing High-Fidelity Training Capabilities Using Subjective and Objective Tools. In *2008 Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) Proceedings.* Orlando, FL: National Security Industrial Association.

Schreiber, B. T., Schroeder, M., & Bennett, W. (2013). Distributed Mission Operations Within-Simulator Training Effectiveness. *The International Journal of Aviation Psychology*, 254-268.

Schreiber, B. T., & Bennett, W. Jr. (2011). Distributed Mission Operations Within-Simulator Training Effectiveness. *International Journal of Aviation Psychology, 21*(3), 254-268.

Schreiber, B. T., Stock, W. A., & Bennett, Jr., W. (2006). *Distributed Mission Operations Within-Simulator Training Effectiveness Baseline Study: Metric Development and Objectively Quantifying the Degree of Learning* [Report No. AFRL-HE-AZ-TR-2006-0015-Vol II]. Mesa, AZ: Human Effectiveness Directorate, Warfighter Readiness Research Division.

Schreiber, B. T., Watz, E., Bennett, W. Jr, & Portrey, A. M. (2003). Development of a Distributed Mission Training Automated Performance Tracking System. In *Proceedings of the Behavioral Representations in Modeling and Simulation (BRIMS) Conference*. Scottsdale, AZ.

Schreiber, B. T., Watz, E. A., & Bennett, W. Jr. (2003). Objective Human Performance Measurement in a Distributed Environment: Tomorrow's Needs. In *2003 Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) Proceedings*. Orlando, FL: National Security Industrial Association.

Watz, E., Keck, L., & Schreiber, B. T. (2004). Using PETS Software to Capture Complex Objective Measurement Data from Distributed Mission Operations (DMO) Environments. In *Proceedings of the 2004 Spring Simulation Interoperability Workshop*. Arlington, VA. Paper available as 04S-SIW-143.