SIMILARITIES AND DIFFERENCES IN THE IMPLEMENTATION OF DISTRIBUTED MISSION TRAINING

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ABSTRACT

In November 2001, engineers and researchers from the US Air Force Research Laboratory, in Arizona, the Defence and Civil Institute for Environmental Medicine in Toronto, Canada, and from the UK Ministry of Defence, Defence Science and Technology Laboratory and QinetiQ Ltd, in Bedford, UK conducted a coalition, Distributed Mission Training (DMT) research event. This international exercise supported development of alternative implementations and applications of DMT by the cooperating, partner nations. The UK approach focuses on mission planning and coordination with only one mission engagement per day supported by a team of subject matter experts. The US has focused on tactical execution by providing a large number of limited engagements with few supporting personnel required. In the US, training events are conducted at individual operational units, which now have four-ship mission training centers. The majority of training activities are conducted at these mission training centers with emphasis on four vs many, beyond visual range air-to-air engagements. The US – Canada – UK coalition DMT exercise was based on two previous, RAF combined air operation exercises that focused on training coordinated actions of air-to-air, air-to-surface, and command and control entities. The differences between US and UK implementation and application of DMT provide an ideal opportunity to examine alternative approaches for using similar training technology to fulfill different training objectives and current training methodology.

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In November 2001, engineers and researchers from the US Air Force Research Laboratory (AFRL), in Arizona, the Defence and Civil Institute for Environmental Medicine in Toronto, Canada, and from the UK Defence Science and Technology Laboratory (DSTL) and QinetiQ Ltd, Bedford UK conducted a coalition Distributed Mission Training (DMT) research exercise. This international, cooperative exercise made use of the flexibility provided by technologies that support alternative implementations and applications of DMT.

DISTRIBUTED MISSION TRAINING

Not unlike the World War Two Link Trainer (Hoek & Link, 1993), the US DMT concept emerged from a technology push rather than being pulled from well-defined requirements. The Simulator Networking (SIMNET) project in the late 1980s demonstrated both novel technology and an alternative approach to simulator training based on multiple players gaining experience in unstructured, real-time, combat scenarios (Alluisi, 1991). Since SIMNET, DMT and related systems have been developed to provide scenario-based, team training using interacting, real-time virtual and constructive simulators. The basis of learning in DMT is gaining experience in a controllable combat environment. The instructional designer's primary training intervention in DMT is the specific DMT system configuration and the design of combat scenarios. In the US, strategies for developing DMT systems, syllabi, and scenarios have been developed by Army (Campbell, Quinkert, & Burnside, 2000), Navy (Smith-Jentsch, Zeisig, Acton, & McPhearson, 1998), and Air Force (Bennett & Crane, 2001 and, Colegrove & Alliger, 2001) researchers. In the UK, where the focus is on collective, or multi-team, training (Smith & McIntyre, 2002), the NATO label MTDS (Mission Training via Distributed Simulation) is used (Tomlinson, 2002), to clarify, and indeed emphasize, that the concept and implementation are different from the US DMT program and its typical form.

Specific implementations of DMT and MTDS depend on three factors. The first factor is the selection of virtual players including the number and types of platforms, ordnance loaded, roles of the various players, and the type of missions to be conducted. The second factor in DMT/MTDS implementation is the configuration of constructive players. Elements to be considered are the number and types of friendly and enemy players; quality of platform, sensor, and weapons models; scripted tactics; behavior representation; and models of intelligence/autonomous actions. The third and often under appreciated factor is DMT/MTDS mission definition and support. This includes definitions of the overall mission objectives and preparation of supporting materials such as Air Tasking Orders (ATOs), special instructions (SPINS), intelligence and weather briefings, charts and mission planning materials, and the participation of support personnel including a White Force cell (exercise development and management) and role players. Even within the limited domain of training fighter and other fast jet pilots, experience in the US and UK has demonstrated that similar training technologies can be used in different configurations to support very different training applications.

US DMT RESEARCH EXPERIENCE

Early DMT Research

Houck, Thomas, & Bell (1991) investigated the potential value of multi-player simulation for training F-15 pilots and Air Weapons Controllers using a simulator complex designed for engineering development. This research demonstrated that multi-player simulation provides valuable training for individual skills that are required in a team context such as communication and maintaining situation awareness. Crane (1994) replicated Houck et al.'s findings using lower cost, distributed systems based on SIMNET architecture. Bell et al. (1996) demonstrated the effectiveness of distributed simulation for training combined air and ground operations and close air support. These studies found that training payoffs are a function of both simulator capabilities and opportunities for aircraft training. Greatest training benefits are realized from DMT when the simulators provide required levels of functional fidelity, aircraft training opportunities are severely constrained, and simulator training events are designed to take best advantage of the system capabilities.

RoadRunner '98: Assessing DMT for a Range of F-16 Missions

The capabilities of AFRL's four-ship F-16 DMT testbed were assessed in the RoadRunner '98 exercise (Crane, Schiflett, & Oser, 2000). This exercise incorporated virtual F-15s, F-16s, and AWACS Air Weapons Controllers conducting a variety of air-to-surface missions plus one Defensive Counter Air (DCA) air-to-air mission. RoadRunner '98 participants were emphatic in reporting that the DCA mission in a beyond visual range environment (BVR) was the best combination of exploiting DMT strengths, avoiding weaknesses, and complementing aircraft training. Surface attack missions were judged much less useful in that they replicated range training events. Participants also reported that limited and incomplete out-the-window visual imagery degraded simulator training utility; both surface and air targets were difficult to see at tactical ranges. Based on these results, AFRL researchers focused DMT effectiveness studies on BVR multi-ship, multi-bandit, Dissimilar Air Combat Tactics (DACT) training including DCA and Offensive Counter Air (OCA) missions.

Implementing DMT for BVR Air-To-Air Missions

Having selected multi-ship, BVR air-to-air training as the focus for training effectiveness research, AFRL identified specific training objectives for this mission and then optimized DMT implementation. Training objectives were based on both individual and team skills. Individual skills included radar mechanics, i. e., detecting, targeting, and sorting multiple maneuvering aircraft in accordance with the briefed plan, weapons employment, and tactics selection by the flight lead. Team skills included communication within the flight and with the Air Weapons Controller, situation awareness, tactical execution, and decision making.

Selection of Virtual Players: Four F-16s plus one Air Weapons Controller were incorporated into the AFRL testbed. Each F-16 simulator incorporates a high-fidelity, fully configured F-16 cockpit surrounded by a full-field-of-view visual display. The Air Weapons Controller's station is a simulated AWACS console.

Behavior of Constructive Players: Training syllabi were built around computer generated forces using a building block format from relatively simple to complex missions. Constructive forces were limited to adversary fighter aircraft plus the E-3 AWACS. In OCA sweep missions, enemy (adversary) force behavior progressed from simple, non-maneuvering or reactive formations early in training to multiple, reactive, maneuvering groups of different types of aircraft. DCA missions use the same concept of increasing from simple to complex and adversary forces consist of multiple waves of aircraft, including air superiority fighters and ground attack aircraft.

DMT Mission Definition and Support: The OCA mission objective was to engage and kill or negate adversary fighters while DCA mission teams were to defend their home airfield from air attack through the assigned vulnerability period. A White Force subject matter expert briefed pilots and controllers on the mission type and objectives including intelligence on the enemy air and surface forces. In addition, the subject matter expert observed the team's briefing and worked with their senior pilot to ensure that the selected scenarios would provide the experiences required to meet training objectives.

The typical training day in AFRL's DACT training program was based on two simulator flights per day. Each flight began with a one hour brief by the flight lead focusing only on tactical execution. Other components of an actual mission briefing such as take-off, fence-check, emergencies, and landing were omitted. After the briefing, teams flew one hour simulator missions. Each scenario was initiated with the aircraft in mid-air with adversary forces beyond F-16 radar range. Missions progressed to a logical conclusion with training objectives failed or met, one force killed or the F-16's out of missiles and coordinated a return to base. After a logical conclusion, the subject matter expert, acting as mission director, would terminate and reset all aircraft to initial conditions and begin another scenario. In OCA missions, teams would experience six to eight setups per hour. In DCA missions, teams were assigned a vulnerability period of 15 – 20 minutes and flew until the end of the vulnerability period, training objectives failed or met, or when one team was killed. DCA missions normally accomplished three or four scenarios per hour. Real-time kill removal was enabled so that virtual and constructive entities were deleted from the exercise when shot down. Each mission was followed by a 90 minute debrief led by flight lead. Debrief included video replay of the mission, review of individual performance, determining lessons learned, and identifying improvements for the next mission. This sequence was repeated in the afternoon. Specific time for mission planning was not included in the schedule. Planning was based on squadron standards, flight lead preferences, and after-hour discussions.

Many teams of F-16 pilots and Air Weapons Controllers have participated in AFRL research exercises since 1999. Exercise training objectives have included augmenting aircraft continuation training for experienced pilots, preparation for Mission Qualification Training, support for Flight Lead Upgrade training, and preparation for Weapons School. Overall, experience using the F-16 multi-ship testbed facility at AFRL improves performance on subsequent flying training exercises and enhances skills in radar mechanics, communications, tactical execution, situational awareness, and decision making.

UK RESEARCH EXPERIENCE

Research experience in the UK includes both development of an air-to-air system for use in a training squadron and a combined air-to-air and air-to-surface system designed to complement range training exercises for more experienced pilots.

JOUST simulation system

The JOUST system (Huddlestone, Harris, & Tinworth, 1999) as installed at squadron bases is a tabletop, two-aircraft simulator system for Tornado F3 pilots and navigators. JOUST was integrated into the pairs (two-ship) tactics phase of Operational Conversion Unit training for F3 crews. Each system consisted of pilot and navigator stations with controls and displays represented on a tabletop computer system equipped with joysticks. The Tornado crews were supported by an Air Weapons Controller and were opposed by an adversary force of one or two virtual aircraft flown by instructors, also supported by an Air Weapons Controller. Trainees alternated flying the JOUST system and aircraft training missions for the six aircraft sorties in the pairs tactics phase. The first two missions were flown against a single enemy aircraft (2 vs 1) and the remainder were flown against two aircraft (2 vs 2). Other factors used to increase the intensity of training were enemy missile range, ownship missile capabilities, and employment altitude. A staff instructor replayed and debriefed trainees after each setup during the training period.

Students with JOUST training demonstrated fewer failing scores on subsequent aircraft sorties. Specific skills that were enhanced included chaff and flare employment and visual weapons employment. Instructor pilots also rated students with JOUST experience as having improved situation awareness and tactical leadership skills and, "…greater mental capacity available during the sorties," (Huddlestone, et al., p. 394).

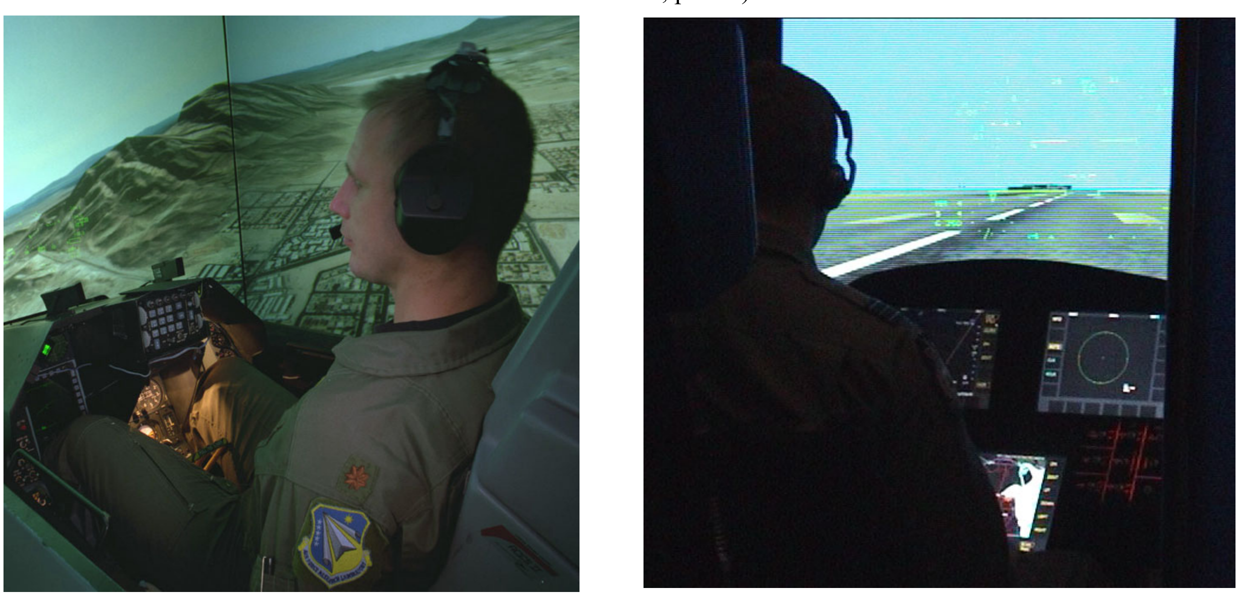

Figure 1. AFRL and DSTL/QinetiQ simulator cockpits.

Distributed Simulation for Combined Air Operations (COMAO) Training

The JOUST system was limited to one aircraft type and used for conversion and continuation training. More recent developments in the UK have focused on creating an operationally realistic synthetic environment for training Combined Air Operations (COMAO) (McIntyre & Smith, 2002). As part of the UK Ministry of Defence sponsored Applied Research Programme, and in cooperation with DSTL, the Defence Science and Technology Laboratory, a multi-cockpit system was developed at the QinetiQ, Ltd facility in Bedford. Based on the advice and experience of a Royal Air Force military advisor attached to DSTL, and reflecting also the ethos of the Tactical Leadership Programme, NATO's school for tactical aircrew at Florennes, Belgium, the COMAO system utilized integration of virtual and constructive simulations for both friendly and enemy forces supported by a team of role players and voice actors. This prototype training system was evaluated in two UK only exercises, Trial Ebb & Flow and Trial SYCOE (Synthetic COMAO Experiment), and then in a coalition exercise, Trial VirtEgo.

Trials Ebb & Flow and SYCOE

The DSTL/QinetiQ COMAO system was evaluated during trials involving front-line aircrews together with a White Force exercise management cell of exercise designers, managers, role players, and voice actors from the Royal Air Force's Air Warfare Centre. The objective of these trials was to assess the utility and effectiveness of distributed simulation to train front-line crews for COMAO missions (McIntyre & Smith, 2000; 2002).

Virtual simulators were developed for Tornado F3 (air defense) and Jaguar (ground attack) crews. Constructive simulations for friendly F-16CJ (Suppression of Enemy Air Defense [SEAD]), A-10, F-15E, EA-6B, F-15C, E-3 AWACS, KC-135, and Nimrod were developed together with enemy MiG-23, MiG-25, and Mirage fighters plus an integrated air defense system including early warning radars, SA-2, 3, 6, and Roland Surface to Air Missiles (SAMs). Role players served as the Mission Commander, and Intelligence Officer, and AWACS Air Weapons Controller. Other role players controlled tabletop virtual simulators or operated constructive simulations and could redirect constructive entities as required. Role players served as friendly Combined Air Operations Center (CAOC) personnel and as enemy air defense and missile controllers. Voice actors backed up constructive simulations for air traffic control, the F-16 SEAD element, and EA-6B electronic warfare crew.

Selection of Virtual Players: Real-time simulators were provided for Tornado F3 and Jaguar GR1A crews. Four virtual simulators were developed for both Tornado and Jaguar crews. The lead pair for each type (Tornado 1 and 2; Jaguar 1 and 2) flew in generic fighter cockpits enclosed in wide field-of-view visual display systems. These cockpits were generic in that they supported weapons systems specific functions but used non-specific controls and displays. The second pair for each type (Tornado 3 and 4; Jaguar 3 and 4) were more generic cockpits with a single-screen visual display. The lead ground attack pilot, Jaguar 1, served as Package Commander for the composite force.

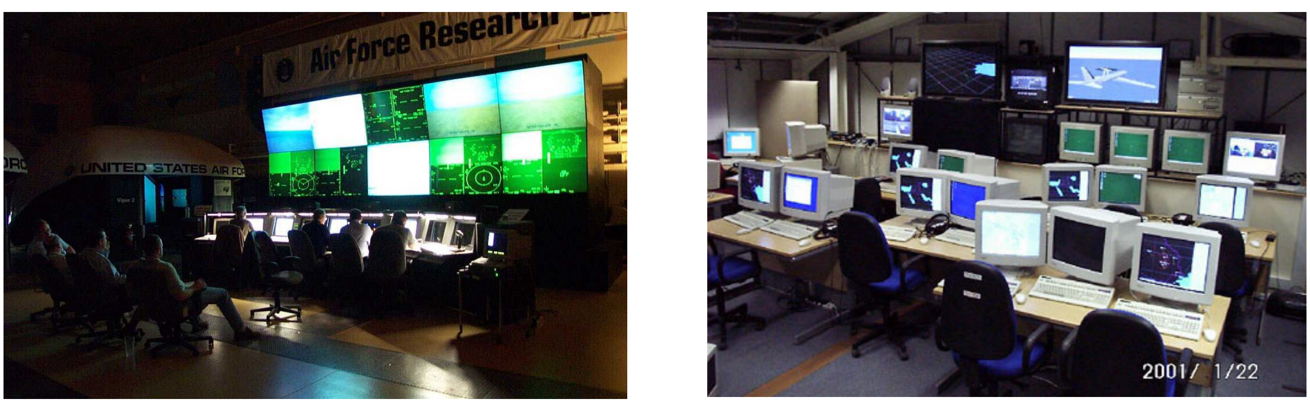

Figure 2. AFRL and DSTL/QinetiQ exercise control and management facilities.

Behavior of Constructive Players: Constructive adversary and friendly forces were programmed to provide operationally realistic coalition missions within a dynamic, high-threat environment. Scenarios were designed to represent sequential days of an escalating combat situation (McIntyre & Smith, 2002). The behavior of constructive forces, either pre-programmed or under control of a role player, served to provide training injects (i. e., trigger events). These injects were defined by the White Force to ensure that trainees encountered situations requiring them to exercise the skills specified by training objectives.

Mission Definition and Support: Offensive, composite force operations were selected as the training focus. Multi-player COMAO exercises incorporated extensive participation of the White Force in mission preparation, planning, and execution. Preparation before aircrews arrived included specification of training objectives, programming constructive forces to include training injects, generating ATOs and SPINS, and listing intelligence information for aircrews. During the exercise, White Force personnel serving as role players acted as Mission Commander to present the ATO and SPINS, and as Intel Officer to give intelligence and weather briefings. These role players were available during mission planning to answer questions from participating aircrews.

The typical training day consisted of one flying sortie per day (one hour) with five hours of preparation and two hours of debrief. The Mission Commander issued the ATO and SPINS and the Intelligence Officer presented the intelligence and weather briefings at the start of each day. Under leadership of the Package Commander, aircrew spent the next several hours brainstorming and preparing mission plans using actual mission planning systems. Briefings were prepared and presented within formations and the Package Commander presented a mass briefing for the Mission Commander. The White Force then determined if additional training injects were required based on training objectives and the briefed mission plan while the aircrews took a lunch break. If required, QinetiQ technical staff re-programmed constructive simulations before take-off in order to ensure that they matched the aircrews' latest plans. COMAO missions were flown from takeoff through touchdown. After the mission, debriefs were conducted within each formation followed by a mass replay and debrief. COMAO missions were repeated over the days of the trial in escalating conflict.

Trial participants and White Force personnel rated COMAO training as highly beneficial for practicing operational procedures, developing tactics, understanding other teams' roles and capabilities, and exploring 'what-ifs' in the scenario. Other cited benefits of simulation-based collective training included gaining experience in the Package Commander's role and exposure to the fog of war (McIntyre & Smith, 2002).

Coalition DMT/MTDS: Trial VirtEgo

This coalition DMT/MTDS exercise is described in detail by McIntyre, Smith, & Bennett (2002) and Greschke, Mayo, & Grant (2002). To conduct this exercise, the QinetiQ/DSTL simulation facility in Bedford, UK was networked with the virtual F-16s at AFRL in Arizona and the Defence and Civil Institute of Environmental Medicine in Toronto, Canada via secure data links. RAF aircrew in Trial VirtEgo were students in the Royal Air Force Combined Qualified Weapons Instructor Course. Students participated in this coalition DMT before the COMAO phase of the Weapons Instructor Course. Instructors stated that students typically experience difficulty coordinating and communicating between flights of different aircraft types early in COMAO training. Training objectives in Trial VirtEgo included enhancing understanding of other aircrafts' capabilities, roles, and limitations; improving team working skills, and gaining experience in planning, briefing, executing, and debriefing COMAO missions in a high threat environment. Selection of virtual players, behavior of constructive entities, and DMT mission definition and support were similar to the previous COMAO trials except that the F-16 pilots participated as a distributed (non co-located) element. The F-16s served a ground attack role on the first day and as OCA escort for the Jaguars on the second day.

Feedback from students and instructors during the trial was highly positive regarding the effectiveness of the DMT/MTDS exercise for meeting training objectives. Instructors in COMAO aircraft training stated that the students with simulator-based experience were better prepared than previous classes and demonstrated higher levels of skill early during the subsequent live flying training.

SIMILARITIES AND DIFFERENCES BETWEEN US AND UK APPROACHES TO DMT/MTDS

Interoperability standards such as SIMNET, Distributed Interactive Simulation (DIS), and High Level Architecture (HLA) support the development of dissimilar but compatible systems to meet different training needs. Comparison of the AFRL DMT and DSTL/QinetiQ MTDS systems demonstrates the impact of training application on system design and instructional strategy.

Figure 3. AFRL and DSTL/QinetiQ debrief facilities.

Technologies

The US DMT and UK MTDS systems are interoperable based on DIS standards. Specific implementations of simulator technologies are, however, very different.

The AFRL simulators are full-fidelity trainers specific to the F-16C with full field-of-view visual displays. The AFRL AWACS console simulator is also specific to the aircraft system but not current. The UK MTDS systems are a mix of cockpits and player stations. The DSTL/QinetiQ system has four virtual cockpits (two Tornados and two Jaguars) with wide field-of-view visual displays plus four limited cockpits with forward-only visual. This system was developed from general research facilities and not specifically built for collective training research. All cockpits are generic with limited relation to actual aircraft. In addition, the system incorporates tabletop systems for virtual adversary air threats and surface-to-air defense plus stations for role players and voice actors.

Both the US and UK systems are linked by a DIS network. DIS sub-systems such as data logging, replay, exercise control, communications, and computer generated [constructive] entities are different but interchangeable. Overall, the two multi-ship simulator systems represent a different mix of compatible technologies: developers at AFRL selected fewer, higher-fidelity trainers where the DSTL/QinetiQ designers in the UK selected more limited-fidelity trainers.

Applications

Both programs incorporate procedurally oriented, individual skills training with mission-oriented, team skills training for communication, decision making, situation awareness, and cooperative tactics. The US focus is on BVR air-to-air with AWACS support where the UK focuses on COMAO incorporating both air-to-air and air-to-surface operations in a large package of aircraft (40 or more) typical of actual deployments. The US training application emphasizes tactical execution during missions. The UK application emphasizes planning and coordination activities that occur before flying the mission, as well as flying and debriefing.

Implementations

Training focus The US approach maximizes flying and debrief by scheduling two one-hour flying periods per day with multiple setups per hour. An elaborate replay / debrief system provides automated mission reconstruction and complete situational awareness during debrief so that time devoted to mission training is maximized. This schedule allows teams to focus discussions on how well they executed their mission plans, what worked, and what didn't, and how to improve their performance in the next mission. The UK approach emphasizes planning and coordination: one mission per day with five hours from issuing ATO to take-off which mirrors a typical live COMAO type training exercise such as Red Flag. This allows time for the mission commander's brief plus intel and weather briefings with additional time for inter-team brainstorming before intra-team mission planning. This phase of the training day concludes with a briefing for the Mission Commander that allows a final opportunity to identify and resolve problems before flying the mission.

Scenario design and trigger events The AFRL research team created a large scenario library by pre-programming many scenarios of varying complexities. Various levels of complexity present variations on similar tactical problems. For example, several different scenarios have been programmed based on a flight of four adversary fighters. In these scenarios, the aircraft attack as a single group, as two groups separated in azimuth, two groups separated in range, two groups in a short-range leader-trailer formation, or in combinations of two maneuvering pairs. The instructor then selects the scenarios to be presented in a DMT session based on training objectives and the experience level of participating pilots.

The UK approach is to design only one scenario for each MTDS mission that incorporates some pre-planned trigger events based on training objectives. In addition, the White Force also devises and programs other trigger events based on the briefed mission plan. After the Package Commander presents the mission plan, the White Force confers while participating aircrew take their lunch break. Strengths and shortfalls of the plan are discussed and training injects are devised to reinforce training objectives. These trigger events are then programmed into the system by the technical staff or are executed by the White Force during the mission.

Training support personnel Only two full time people are required at AFRL – a systems operator and a subject matter expert – to support a DMT exercise. System maintainers are available on-call. The subject matter expert works with the team's leader to identify training objectives and select scenarios from the pre-programmed library. The subject matter expert then works with the system operator to execute the selected scenarios. The UK implementation requires system operators and on-call maintainers plus an extensive White Force consisting of role players, voice actors, and exercise controllers.

Training strategies / interventions While many aspects of DMT/MTDS implementation at AFRL and DSTL/QinetiQ are different, the training strategies and interventions are very much alike. The strategy is based on working with instructors to identify areas where additional training would be of greatest value and within the capabilities of the DMT/MTDS systems. In the US, the selected objectives focus on air-to-air radar and communications skills for DACT missions against multiple, maneuvering targets and on executing cooperative tactics such as grinder or de-louse. In the UK, training interventions focus on inter-team coordination, enhancing understanding of other team's capabilities and limitations, and devising coordinated mission plans. The next step in the training strategy is to identify trigger events, i. e. scenario elements that require participants to exercise the desired skills, and incorporate different examples of trigger events (training injects) into the scenarios. Examples of trigger events at AFRL include increasing complexity of enemy tactics from non-maneuvering adversary force aircraft to pre-programmed maneuvers to autonomous maneuvering. Trigger events are tailored to the needs of specific teams of pilots and to the briefed mission plan by selecting from a library of scenarios – only limited run-time control of scenarios is possible. Training interventions in the DSTL/QinetiQ system incorporate both pre-programmed and run-time events. An example of a pre-programmed trigger event is inserting poorly coordinated mission timelines into the ATO for teams to detect and reconcile. Trigger events are also programmed into constructive forces after the mission briefing while others are controlled by the White Force cell during the mission under direction of the exercise controller. Examples include jamming of voice communications, or unexpected re-location of a SAM site. Subsequent DMT/MTDS missions in both countries incorporate related trigger events. In the US, these events are based on increased complexity of tactical problems while in the UK the triggers represent subsequent days of ongoing air operations in the simulated campaign.

In addition to incorporating carefully designed trigger events into DMT/MTDS scenarios, both the US and UK implementations include mission replay and debrief to review what happened with focus on where things went badly. Examples include poor mission plan, the plan not effectively communicated/understood during briefing, a situation not recognized during the mission, task overload, loss of situation awareness, or failure to execute in accordance with the briefed plan.

Training benefits / limitations: Like the training strategies using DMT/MTDS, the benefits and limitations resulting from DMT experience using the AFRL or DSTL/QinetiQ systems are similar within their given focus, i.e., tactical execution or mission planning. Pilots with DMT experience performed better than other pilots in subsequent flying training events. USAF pilots who participated in DMT before aircraft training in flight lead upgrade or in the Air Combat Tactics phase of Weapons School repeated fewer training missions due to non-effective performance. Instructors in the RAF Weapons Instructor Course report that students with MTDS experience demonstrated increased effectiveness during their first COMAO mission. Subject matter expert ratings of pilot performance in DMT/MTDS exercises in both countries showed improvement in team skills: planning, execution, communication, and situation awareness. On the other hand, pilots and instructors in both countries report that DMT/MTDS has limited effectiveness for tasks requiring out-the-window visual detection of other aircraft such as tactical formation, visual identification, basic surface attack, basic fighter maneuvers, or visual missile employment.

Lessons Learned in Both the UK and US

- Integration and testing of distributed simulation networks are very complex tasks – interactions among entities that work correctly in one-on-one testing may behave differently when the network is fully active.

- Training objectives must drive system development: "Without a training requirement and the transformation process of generating a synthetic environment, all you have is a group of connected simulation components," (Greig, Mayo, & Crush, 2000).

- Measurement of pilot performance and correlation of process measures with mission outcome measures remain difficult problems.

- The relative effectiveness of distributed vs co-located multi-player simulation remains an open issue. Technologies and procedures to enhance quality of inter-site interactions among participants are being developed and evaluated.

- Training utility of DMT/MTDS experience comes from complementing, not replacing, aircraft training such as preparation for high-cost, infrequently practiced missions and augmenting limited opportunity for range experiences with additional time on task such as DACT or defense against surface-to-air missiles.

DISCUSSION

The similarities and differences between US DMT and UK MTDS research programs in training effectiveness demonstrate the flexibility of multi-player simulation for enhancing individual, team, and inter-team skills.

Technology

While the technical systems used in the two countries are – and have been proven to be – interoperable, they are not identical. The AFRL system has fewer cockpits with high fidelity and full field-of-view visual displays plus an AWACS control station where the DSTL/QinetiQ system has more virtual players incorporating a mix of generic cockpits, visual display systems, and player stations.

Applications and Implementation

The selected training applications and implementation of DMT/MTDS are very different. The US focuses on four-ship, beyond-visual-range air-to-air combat compared to the UK focus on large COMAO packages featuring combined air-to-air and air-to-surface formations, together with suppression of enemy air defense and electronic warfare elements. The different applications result in different DMT/MTDS implementations: two vs one simulator missions per day; emphasis on execution vs emphasis on planning; and minimum personnel complement vs an extensive White Force cell. Other differences include use of an extensive library of pre-programmed mission scenarios incorporating different examples of trigger events vs a small scenario library with judicious run-time interventions to generate trigger events and high fidelity, in-depth debriefs vs less in-detail, but still comprehensive, review of overall mission coordination and effectiveness.

Training Strategies, Interventions, and Benefits

The training strategies and interventions used in both countries are very similar, being based on analysis of training objectives and development of DMT/MTDS scenarios incorporating trigger events based on training objectives. Participants plan, brief, fly, and replay/debrief their DMT/MTDS missions and then repeat this sequence with similar but more complex missions. The benefits of DMT/MTDS are also similar with greatest skill enhancements for team skills and individual skills exercised in a team context. Training limitations result from limitations in DMT/MTDS technologies. DMT/MTDS is not well suited for close-in air combat due to pilots' limited ability to detect/orient/identify aircraft targets at realistic ranges, given resolution of the visual displays, and the constant 1g environment.

CONCLUSIONS

DMT in the US and MTDS in the UK, incorporating interacting virtual and constructive, real-time simulations in a realistic, immersive mission-orientated environment, offer an emerging, and powerful, new training medium. Training effectiveness research is focusing on identifying tasks and skills well suited to DMT/MTDS, the technical capabilities required to support training, and the processes and procedures that provide effective training using DMT/MTDS systems. US and UK researchers selected different training objectives for DMT/MTDS with the resulting systems being comprised of different but compatible technologies. Implementations of DMT/MTDS are also very different. However, both groups used the same strategy to develop scenario-based training interventions with replay and debrief after each mission. Research has demonstrated that the training benefits for participants are very similar; so are training limitations and systems integration problems.

DMT/MTDS technologies provide design flexibility, immersion into the synthetic combat environment, and opportunities for enhancing a wide range of individual and team skills. Application of a well-constructed training strategy is the crucial step in transforming technology into effective training. Further multi-national collaboration in this vital research field will continue to exploit the similarities and differences discussed here, to provide our air forces with effective mission training.

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