Game On: Goal Based Scenario, Game Based Learning, and Narrative Applied to Simulator-Based Training

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ABSTRACT

The current MQ-9 Initial Qualification Training (IQT) curriculum uses a mix of classroom, simulator, and live-fly training instruction. The curriculum has experienced challenges with meeting aircrew readiness requirements. Specifically, resource constraints and outside factors such as weather affect the ability to execute live-fly training. These negative impacts are driving the effort to increase simulator-based training events. In order to meet the increasing demand for MQ-9 flight certified aircrews, MQ-9 training is executing an experimental redesign to expand use of Live, Virtual, and Constructive (LVC) capabilities within the MQ-9 high-fidelity aircrew training simulator.

The LVC lessons include additional roles in simulator-based training scenarios that approximate the multimodal environment of live-fly exercises. These scenarios loosely mimic the multi-role and multimodal engagement style of many popular video games. These games use narrative devices to engage users in situations that require critical thinking and problem solving to progress toward goals within complex multimodal environments.
The goal-based scenario (GBS) framework describes a learning environment that exploits the learn-by-doing method demonstrated in these games. Game Based Learning (GBL) explores the concept that games are effective in teaching skills not just because of engagement, but because the skills are applied within the narrative context of the game. Both the GBS framework and GBL depend on a narrative thread or storyline, and that narrative ties to the learning objectives of training.

This paper considers the tools and methods used in the simulator-heavy training and applies academic and industry findings to investigate how storytelling and narrative techniques in GBS and GBL can be combined with the LVC capabilities within a high-fidelity aircrew training simulator to improve training outcomes and aircrew readiness.

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INTRODUCTION

Storytelling and narrative are parts of effective teaching/learning strategies. Stories have been used since pre-written history to pass information and experience and are woven into human consciousness. The Epic of Gilgamesh, written c. 2150 BCE, it is a Sumerian story which interweaves mythology with historical fact. It pre-dates Homer's writing by nearly 1500 years making it the oldest recorded story known to date (Mark, 2018). As exhibited in historical stories like The Epic of Gilgamesh, storytelling narratives create meaning, memory, and identity (Rappaport, 796). Stories turn the abstract into the relatable and turn complex concepts into a memorable format.

Games too, have long been used to teach lessons, with children roleplaying adult situations to explore their world and place in it. Computer and video games have been and are continuously studied as tools to teach and facilitate learning. In particular Goal-Based scenarios and Game Based Learning have been explored as ways to identify and explain/exploit the traits of successful leaning within games.

One of the first times video games were utilized for educational purposes was with Logo Programming. Logo was the brainchild of Seymour Papert, a mathematician who co-founded the MIT Artificial Intelligence Laboratory in the mid-1960s with Marvin Minsky. The purpose of Logo was to help teach programming language in a game-based environment. The student would have to learn programming commands in order to move a turtle. The turtle first started off as an actual robot on the floor that would respond to commands, but eventually evolved into a computer-generated image (Logo Foundation, 2019).

In 1971, three student teachers, Don Rawitsch, Bill Heinemann, and Paul Dillengerger created an educational video game known as The Oregon Trail. The purpose of the game was teach schoolchildren American History in a fun, interactive way. It interwove game-based storytelling (a settler family making their way on the Oregon Trail) with goal-based scenarios (bartering with limited supplies, travel strategy, etc). Rawitsch joined the Minnesota Education Computer Consortium (MECC) in 1974 and brought the code for Oregon Trail with him. MECC developed their own version and began distributing it widely to schools. The game has been updated numerous times over the past four decades and remains one of the most popular and successful educational video games to date (The Strong National Museum of Play, 2019).

This paper focuses on how the MQ-9 program uses the capabilities of the Predator/Reaper Mission Aircrew Training System (PMATS) high-fidelity simulator in Initial Qualification Training (IQT). Particularly, how it utilizes these capabilities in the context of Goal Based Scenarios (GBL), Game Based Learning (GBL) and Narrative in the Sim-Heavy experiment. The Air Education and Training Command (AETC) at Holloman Air Force Base in New Mexico is conducting the Sim-Heavy experiment focusing on expanding simulator training, reducing the need for live-fly training, and improving aircrew training production. This paper considers how GBL and GBS theory and practice, along with narrative techniques within games are reflected in the Sim-Heavy experiment.

GOAL BASED SCENARIO, GAME BASED LEARNING, AND NARRATIVE RESEARCH

For the purposes of this paper, the work of four primary researchers will be considered in relation to the Sim-Heavy experiment: the Game Based Scenario research of Roger Schank, the Goal Based Learning research conducted by Jessica Trybus, the Role of Narrative in Game Design research by Michele Dickey and James Gee's work on video games, learning and literacy.

The term "game" can mean different things to different people (Whitton, 2010). For clarity and for the purposes of this paper, when the term "game" is utilized, it should be considered in relation to the definition of "serious game," or an activity that is still entertaining and engaging but used for another purpose such as training and education (GAIA, 2019). Serious games are a subset of serious storytelling, or storytelling that has purpose beyond entertainment (Lugmayr et al., 2016).

Roger Schank (1992), a foremost Goal-Based Scenario (GBS) researcher, asserts that every aspect of human behavior can be attributed to the pursuit of goals. Some goals are simple, like making a healthy breakfast to provide required energy for the morning. Others are more complex, like creating a five and ten-year career progression plan. Goals are at the root of human learning and studying how people go about pursuing the fulfillment of goals is critical in understanding human cognition (Schank, 1992). If goals are at the root of human learning, then incorporating goals into the learning process would provide a natural path to successful concept installment for the learner.

Schank (1992) notes the importance of GBS allowing for trial and error; risk-free simulation of outcomes to determine the best scenario choice, allowing a learn-by-doing approach. A GBS presents a set of targeted skills and an environment that will motivate the student and enable the productive use of the skills upon completion. In other words, for GBS to run most effectively, a GBL environment with risk-free trial and error is necessary for the learner to solidify the information taught and reach the desired outcomes. In Schank's (1992) work, GBS are stated as "missions" with a backstory providing context and a focus targeting the accomplishment of an objective. These "missions" are often the fuel for video game narrative and design.

Jessica Trybus (2015), one of the leading figures in GBL, defines GBL as "interactive experiences that motivate and actively engage us in the learning process." Within a GBL environment, the user strategically works toward a goal; their actions have consequences along the way, but in a risk-free environment. This allows the user to run action-consequence scenarios and develop an understanding of potential outcomes without the risk of real failure. Trybus (2015) also notes that meta-analysis of flight simulator training, in combination with live-flight training, "consistently produced training improvements compared to aircraft only training."

Michele Dickey (2006) discusses the role of narrative and GBS in compelling game design. She relates the strong narrative elements of many games, particularly adventure games, as providing motivation to user to remain engaged in the game. These same elements of engagement and motivation provide a cognitive framework for learning and retention of information. She provides a six-step framework for applying adventure game narrative into a learning environment: 1) Present the Initial Challenge 2) Identify Potential Obstacles and Develop Puzzles, Minor Challenges, and Resources, 3) Identify and Establish Roles, 4) Establish the Physical, Temporal, Environmental and Emotional, and Ethical Dimensions of the Environment, 5) Create Backstory, 6) Develop Cut Scenes to Support the Development of the Narrative Storyline. We expand on these six points in relation to MQ-9 training in a later section.

James Gee's (Gee 2003) book exploring video games, learning and literacy dives deeply into how humans learn, exploring how video games implement specific principles of learning. We specifically look at his Multimodal Principle - how meaning and knowledge are built up through various modalities (images, texts, symbols, interactions, abstract design, sound, etc.), not just words.

The Applicability of Video Game Narrative to Training

Narrative is part of many video games, and is most strongly seen role-playing, action-adventure and adventure/fantasy games. In some adventure games, the narrative is the primary driver of game design – *Myst* and *Riven* being the foremost examples of this type. In action games, narrative is used to set the scene and create initial motivation, but is often not well developed. Action-adventure games combine a long-term 'quest' or goal within the narrative of the game to drive action and keep players engaged. This sometimes occurs in a non-liner fashion, as exhibited in *The Legend of Zelda.*

Role-playing video games originated out of paper based role-play games – *Dungeons & Dragons* being the classic of this genre. The earliest role-play computer games were text based, and as technology has evolved these games have adapted a more action-oriented style of play. *Diablo* is an example of an action-role-play game. The narrative elements in each of these game genres provide several key elements: establishing role, characteristics and motivation of game's characters, the setting of the story and the environment the game, and the goal or goals of successful play. (Dickey 2006)

Motivation and engagement are important aspects of instructional design, Video games use narrative to engage players, describe motivations of characters, and establish goals. Narrative in the gameplay allows skills and their use to be placed in context, providing a cognitive framework for problem solving (Dickey 2006). Narrative also provides players and environment where known elements (environment, character backstory, rules) and unknown elements can be combined into a possible solution to a problem posed in game. These problem solving instances make for effective learning opportunities.

Much of the language used in video games, particularly action-adventure or role-playing games, aligns directly with language used in military. These games feature GBS-like "missions", and have specific objectives and outcomes for the mission. Many adventure or role-playing video games are directly modeled after military-style engagements, common game examples of this style are the *Medal of Honor* and *Call of Duty* video games. Games of this type are probably very familiar to the airmen who are candidates for MQ-9 training (or any military training).

Military training focuses on three primary areas, skill development, building a framework for rapid problem solving, and establishing shared experience base among team members. Many video games, particularly modern, cooperative multi-player, role-play games share these three elements, of building skills, and applying skills to solve problems/achieve goals with other players. Like military exercises, GBS within games present opportunity to learn a set of targeted skills and an environment that will motivate the student and enable the productive use of the skills upon completion.

THE STANDARD MQ-9 TRAINING CURRICULUM

The Equipment

The Predator/Reaper Mission Aircrew Training System (PMATS) Simulator is a complete high-fidelity training system. As a Remotely Piloted Aircraft (RPA), the MQ-9 crew consists of one pilot and one sensor operator. Unlike traditional aircrew, the MQ-9 pilot and sensor operator remain on the ground and are never airborne in the MQ-9 aircraft. The MQ-9 aircrew control the aircraft using a Ground Control Station (GCS) as the "cockpit." The GCS connects to the aircraft through satellite links.

PMATS has a fully replicated Ground Control Station (GCS), essentially identical to those used to fly the MQ-9, including heads-down and heads-up instrument controls, a tracker display, audio and chat communications, and tactical-situational awareness (TACSIT) tools. It has a high-fidelity visual replication of the sensor and weapons of the MQ-9, fully simulating both pilot and sensor operator stations, a flight model and a simulation engine for creating and managing Computer Generated Forces (CGF).

PMATS utilizes Local Area Network (LAN) connectivity to other PMATS GCS in the same location, providing training in the typical two or four ship configurations. This LAN connectivity provides a multi-player capability for placing multiple MQ-9 crews in a shared exercise, viewing shared tactical information displays and communicating via radio and chat. The LAN can connect other role-players in an exercise via "white cell" stations – a computer station with radios, chat, and TACSIT tools. From the PMATS Instructor Operator Station (IOS), Instructor Pilots (IP) and Instructor Sensor Operators (ISO) control the exercise, triggering and injecting events, as well as marking points in exercise recordings for later debrief. The IOS has full communications capability, as well as an instructor-only radio channel. The PMATS Brief/Debrief System (BDS) records the exercises, automatically tagging events such as weapons release for review along with marks inserted by instructors during execution.

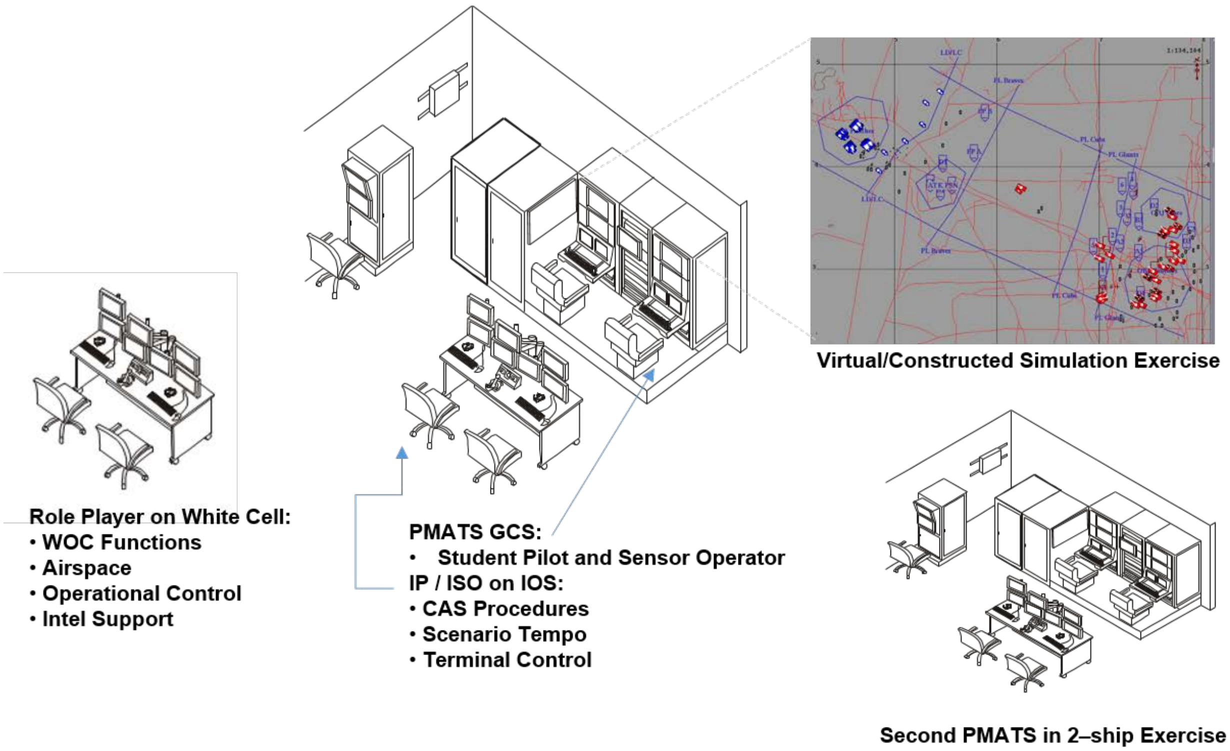

Figure 1 – PMATS Training Environment for IQT Sim-Heavy Experiment

Initial Qualification Training

IQT takes aircrews (one pilot and one sensor operator per crew) from basic flight qualification to being qualified to operate the MQ-9. It consists of seven major phases. The first four focus on the MQ-9 operational basics: 1 – Transition (TR), 2 – Basic Surface Attack (BSA), 3 – Surface Attack (SA), and 4 – Intelligence/Surveillance/ Reconnaissance (ISR). The later phases focus on applying these operational skills in specific situations: 5 – Aerial Interdiction (AI), 6 – Strike Coordination/Search & Rescue (SCAR/CSAR) and 7 – Close Air Support (CAS).

One feature of IQT is the layering complexity of the use of the MQ-9 in the mission, including the introduction and then interaction with all the other players in the mission/operation. Students go from learning the MQ-9 - its systems and tools (radios, sensors, weapons) to learning the environment and protocols in which they will operate. Some of these behaviors and protocols include air traffic control, interaction with joint air tactical controllers on ground, intel mission staff, and operations commanders.

IQT events within the above phases use instructor guided exercises to meet specific learning objectives as detailed in the MQ-9 Training Manual. These events lay out the primary and secondary desired learning objectives, the focus and expected outcomes of the event. Training exercises are either live-fly or simulated, and are built and executed by instructors, targeting the specific learning objectives and proficiency expectations of the event. Once the basics are mastered, the later phases of IQT have exercises of increasing complexity and duration building to content that follows the layouts of operational missions.

THE SIM-HEAVY EXPERIMENT

AETC leadership first conceived the Sim-Heavy experiment in early 2018. They modeled the experiment after the Pilot Training Next experiments going on in Austin. The purpose of the Sim-Heavy experiment was to create a Live Virtual Constructive (LVC) MQ-9 training experiment to increase training efficiency and improve the immediate and long-term combat readiness of MQ-9 Formal Training Unit (FTU) graduates.

The experiment's methodology attempts to discover and overcome FTU training gaps and inefficiencies by leveraging immersive, high-fidelity PMATS simulator and training personnel in a way that meets or exceeds MQ-9 FTU evaluation standards. The experiment is designed to validate benefits and uncover any operational risks associated with this MQ-9 LVC methodology,

The overall goal is to increase the throughput of aircrews though Initial Qualification Training (IQT). This is accomplished by putting more of this the training time in the high-fidelity simulator so that less time would be spent flying the actual aircraft. By using the capabilities of the PMATS high-fidelity simulator to execute additional simulation exercises, training throughput speeds up given that weather days and other live-fly delays are eliminated. Furthermore, simulated training allows for the design and execution of exercises that would not be easily replicated in the real world weapons range of the FTU. The overall goal was to establish if aircrews could be trained at least effectively as the current curriculum in a shorter amount of time at a lower cost.

The Sim-Heavy Experiment Structure

The experiment is designed for three iterations, with each trial consisting of a training class of 5 crews on the Sim-Heavy course, and a control class of 5 crews using the standard training curriculum (63% simulation, 37% live-fly). The initial Sim-Heavy trial, started in Spring 2019, with an increase to 89% simulation (11% live-fly). A second trial is planned starting in late summer of 2019, with an increase the Sim-Heavy training to 94% with 6% live-fly curriculum. Depending on the success of these trial classes as they progress through squadron assignment and Mission Qualification Training (MQT), there is an option to move to a 100% simulation curriculum for IQT in a third Sim-Heavy trial.

The Sim-Heavy experiment structure for trial one and trial two run parallel to the progress of the students moving through the traditional IPT course. The traditional IPT course serves as the control to the Sim-Heavy variable courses. Running the traditional course concurrent with the Sim-Heavy courses serves to relieve administrative challenges surrounding one of the classes running out of sync with the others. The Sim-Heavy trial is incorporated into the standard IQT course scheduling. This incremental update of training is less disruptive than an entire training overhaul. The Sim-Heavy training will be refined during the experiment for future incorporation into the new standard training.

The 711th Human Performance Wing (HPW) selects candidates for both the Sim-Heavy experiment, as well as for the control crews undergoing traditional training. The candidates are selected from the top third of incoming pilot and sensor operator entrants. FTU instructors perform ongoing evaluation during training and adjustment to meet student needs. Supervisors ensure students are not penalized for participation in the experiment.

The Sim-Heavy Experiment Equipment

The simulator equipment for the Sim-Heavy experiment consists of two Block-30 GCS PMATS and two BDS, connected via PMATS LAN, permitting 2-ship exercises. This configuration is expandable to 4-ship exercises. The software configuration for the experiment is the standard PMATS 2407 load, with an early version of several Sensor Operator Fidelity Improvements, slated for general release in 2019. While this configuration is specific to the experiment during trial one, all updates are available to the entire PMATS fleet. The experiment includes two 'white cell' workstations attached to the PMATS LAN, for additional role players in the training scenarios. The "white cell" workstations are computers that have the radio/chat communications, tracker and TACSIT screens of PMATS, as well as ability to control CGF in the exercise. The 'white cell' stations are not yet standard at PMATS installations; however, these may be incorporated into the training at the FTUs based on recommendations from the Sim-Heavy experiment. The functionality of the "white cell" is available on a PMATS IOS, however having additional role-players within exercises adds to the immersive, multi-role, multimodal experience of the exercises.

The curriculum for the Sim-Heavy trial class and the control class is the same, with the exception of the substitution of simulator exercises for several of the live-fly exercises. The Sim-Heavy trial class still has live-fly validation rides to ensure the training in the simulator translates to proficiency required in IQT course.

DISCUSSION

The Application of GBS, GBL, and Narrative in the Sim-Heavy Experiment

The exercises for the Sim-Heavy experiment utilize features of GBS, GBL, and strong narrative elements in order to engage aircrews in learning tasks in an efficient manner with an effective outcome.

The central notion of GBS is the acquisition of skills via repeated practice in an authentic environment (Scrank 1993). Within the military the phrase "train like we fight" embodies this same concept. During IQT, the goals are expressed as the desired learning objectives within each IQT event – essentially mapping each event into a GBS. Utilizing the high fidelity simulator, scenarios can be executed in a low-risk environment, while providing an immersive learning in an authentic environment. There are some training scenarios which are only done in simulation, due to the risks and costs in live-fly execution (e.g. engine fires, landing on damaged landing gear). The execution of training on emergency procedures in particular is one area where flight simulators have been used effectively. While the language is different, these training scenarios fit within the GBS model incorporating active participation by learner in completion of tasks in an authentic environment.

As an exploration of applying GBS and GBL to simulation exercises used in MQ-9 IQT Sim-Heavy experiment, Dickey's (2006) six basic principles for integrating game narrative into the learning environment are used to review the Sim-Heavy experiment. This framework fuses the ideas of game design narrative with instructional design concepts.

1. **Present the initial challenge**
   An exercise starts with an instructional brief with aircrew on the events desired learning objectives, providing our "initial challenge" in the context of GBL. The learning objectives are laid out for each exercise in the IQT training manual, and are incorporated into the simulator exercise by the instructors as the exercises are designed and scripted.

2. **Identify potential obstacles and develop puzzles minor challenges and resources**
   As simulator exercises are built by instructors in preparation for training, they intentionally build in the obstacles and challenges within the script, targeting the specific skills that are needed for the learning objective. This could also include specific emergency procedures or outside influences that are objectives to teach for event. In the simulator, context resources such as weapons and senor capability are typically all available, however some resources can be consumed, and must be accounted for by the aircrew. This provides the opportunity to learn skills in the context of achieving goals.

3. **Identify and establish roles**
   The primary players in any IQT exercise are the trainee aircrew – pilot and sensor operator. As this is training rather than game-play, these roles are known and established. Other roles in scenarios are Wing Operations Center (WOC) providing overall airspace and battle management control, Joint Tactical Air Controllers (JTAC) providing on-the ground targeting feedback, and other aircraft in a given exercise. The instructors had typically executed the additional roles in training – giving the Air Traffic Control calls for example. An integral part of the exercises developed for the Sim-Heavy experiment is the addition of other roles and players via the "white cell" stations.

In addition to the role players on "white cell" stations, the Sim-Heavy exercises introduced the concept of pre-recorded audio "chatter" in the scenarios. This additional audio is executed within the CGF tools, and can be executed within the exercise in association with specific events, as well as being injected on demand by a role player or instructor. This reflects Dickey's (2006) fourth principle:

4. **Establish physical, temporal, environmental, emotional, and ethical dimensions of the environment**
   The physical, temporal, emotional, and ethical dimensions of the environment are established in the mission brief this sets up the exercise as in conjunction with the desired learning objective for the event. The instruction designer uses the components of the simulator technical ability to establish these environmental components of any simulation exercise lesson plan.

The simulator's technical capability is critical in establishing the perception of the physical location of the exercise and temporal - season and time of day. These factors are part of the simulation capabilities via image generation and other CGF tools. Recent PMATS upgrades added significantly to the realism of the weather and atmospheric effects available in simulation, recreating conditions like layered clouds with differing wind conditions. The simulators technical capabilities also provide the environmental factors such as weather and aircraft conditions such as icing or other emergency procedure or equipment failure simulations. Adding the ability to engage with other roles within a scenario contributes significantly to the emotional environment. PMATS communication capabilities, along with the role players on the "white cell" stations provides the aircrew with an aurally immersive experience.

5. **Create a back story**
   The overall context of military training in general provides an underlying backstory to any of the given missions executed in training exercises. In the IQT exercises, the backstory for one event is covered in the required reading and in the instructors briefing. One key part of the mission for the MQ-9 is its ISR role as a "hunter", so a key part of any exercise backstory is the target or objective of the hunt.

6. **Develop cut scenes to support development of narrative storyline**
   Video game cut scenes provide an opportunity to weave narrative into the action in order to enhance game play for the user this is less necessary in a military training scenario for the storytelling aspects. However, we can use the concept of a cut scene to provide opportunity for the instructors to interrupt the scenario to inject feedback to the aircrew.

With a sufficiently robust simulation device, the instructor could inject additional challenges and/or events within a larger training scenario depending on how the user-learner is performing in a given event. This ability to adjust the narrative to the learner's performance within the game gives opportunities to enhance the training outcomes for learners within a simulation based training event.

The purpose of Sim-Heavy training incorporating GBS, GBL, and narrative is not to turn it into a sprawling adventure narrative, fantasy-based game. Rather, it is to utilize some of the features of narrative game based learning to enhance MQ-9 training particularly the integration of the hunter part of the mission. By learning from and leveraging how games engage users in complex scenarios and learning, the Air Force can apply the same narrative techniques to enhance training using the PMATS simulator capabilities.

Application of Narrative

While learning takes place in video games, the video game's purpose is primarily entertainment with the storyline or narrative of the game providing a hook to engage the audience. However, even in video games with an entertainment objective, the player must learn the vocabulary, symbols, and artifacts used within the story to be successful.

James Gee's (2003:76) book exploring video games, learning and literacy explores how games implement various learning principles. Learning at a basic level involves the understanding and mastery of symbology, vocabulary and the rules of a group of participants of a domain. This knowledge is gained through multimodal (i.e.: oral or written languages, images, symbols, sounds, artifacts) experiences. Gee (2003) discusses how human language encodes abstract notions "into words and phrases that constitute metaphors based in concrete, embodied experience of the material world." This transformation of the abstract into concrete experience is exactly what good training exercises accomplish. Good video games (and good training exercises) create situational environments, experiments, and embodied forms of learning and thinking.

Video game narrative construct is different from a story or novel in that the player's choices become part of the story. Gee (2003:76) calls these "embodied stories", covering the player's experiences, perceptions, choices, and interactions within the action of the narrative. This Multimodal Principle of learning exhibited by video games in engaging a learner with visuals, sounds and interactions within the context of a narrative provides opportunities for connection, meaning and mastery of a subject (Gee, 2003:111). By leveraging this type of narrative engagement, realistic simulator exercises can be created. These exercises expand the training beyond memorization or individual skill practice into a multi-option situational decision-making, problem-solving opportunity for learning. In the Sim-

Heavy experiment, the Multimodal Principle directly applies to how the visual, audio and physical features of the PMATS simulation exercises contribute the engagement of the learner,

CONCLUSION

Though full evaluations for the Sim-Heavy experiment are not expected until July 2019, preliminary results are encouraging. Assessment midway through the first trial indicated the Sim-Heavy aircrews are performing as well or better than the control aircrews on the evaluations. The graded performances of the Sim-Heavy crews are performing at or above the expected proficiency levels, with very few instances of inadequate performance, which would require a re-accomplishment of the exercise to achieve a proficient rating. The control group of traditional training shows a more typical result of several instances of inadequate performance requiring re-accomplishment to achieve a proficient rating.

With successful initial IQT results for the Sim-Heavy crews, the next mark of success will be how the Sim-Heavy IQT graduates perform as they go through MQT with their assigned squadrons. This will provide the best indication as to whether or not the Sim-Heavy approach to training has the promised benefits without negative impacts.

A second Sim-Heavy crew trial is scheduled for later in 2019. The second trial is expected to be even more successful as the usage of the immersive capabilities of the PMATS become more refined. Lessons from the first trial will be incorporated into the second trial, including improvement of scenarios and teaching techniques.

Simulation heavy training can provide opportunities to move aircrews through training more quickly, without dependencies on weather or equipment on the flight line. While the simulator cannot provide an exercise of every technique required in live-flight, advances in simulation devices are allowing us to move more of those live-flight activities into the simulation environment. Simulation allows for the safe generation and exercise of tasks that would be risky or expensive to do in the real world. Continuing to use the lessons learned from GBS, GBL, and the Sim-Heavy experiment will continue to allow the Air Force to leverage the best aspects of each theory and technology.

RECOMMENDATION FOR FUTURE RESEARCH

For the first trial, the Sim-Heavy experiment is succeeding in its original intention. Not only does it show that crew could move through IQT faster (if not held to standard schedule), the Sim-Heavy crews scored better during flight tests than their peers in the standard IQT training. This is an encouraging step toward a new era of more rapid, effective MQ-9 pilot training. Given these early successful results, it is expected that trials two and three of the Sim-Heavy experiment will proceed. Continuation of the experiment is certain to help with the discovery of the threshold and objective-level usage of the simulator for more of the fundamental MQ-9 training exercises in this IQT environment.

Further literature review of the research surrounding game-based simulator training in combination with the lessons learned of the first Sim-Heavy trial is recommended. This research can identify techniques to increase crew engagement and mastery of skills within IQT exercises. For example, one feature of good video games is that there are usually multiple paths to solving a given problem. Multiple paths engage users with multiple learning styles or methods of acting, providing a rich environment for exploration and learning. Combining this feature (a multi-path narrative to solution), into future IQT exercises could provide benefits in improved training outcomes.

A near-term opportunity for further research is to expand the use of other role-players in training outside the FTU; providing immersive, multimodal training experiences. Each PMATS installation, even single simulator installations at Air National Guard bases, have LAN capability; the addition of “white cell” stations for additional role-players in an exercise would be a relatively simple technological implantation, the challenge would be having personnel available to role-play with an individual crew. Even without a “white cell,” a role-player can use the IOS to interact with crew training via audio and chat. All PMATS installations can also train with others over distributed mission networks; this includes other MQ-9 crews and other aircraft and operators.

The MQ-9 pilot is in a unique position. Unlike fighter or bomber crews, the PMATS ground control station MQ-9 aircrews utilize is nearly identical to an operational ground control station. The MQ-9 pilot and sensor operator don’t experience the same physical aircraft feedback during live-fly as an F-15 pilot would in the fighter jet; the physical feedback of aircraft in the training GCS are the same as in the operational GCS. The difference between MQ-9 live-fly and simulation is live camera and sensor imagery vice virtual and constructed images, and live communications interactions with other participants in a mission.

As the MQ-9 is operated via ground station through screens, there is an opportunity for additional application of the concepts of GBS, GBL and narrative to expand and improve upon MQ-9 training. While this paper sought to review the current Sim-Heavy experiment's use of these concepts, there is an opportunity to build specific training exercises that implement GBL and narrative to create immersive, multimodal multi-role training events. The technical elements are available within the PMATS devices; the opportunity is there for multi-role over the distributed mission ops networks. What remains is establishing teams of experienced instructor pilots and sensor operators to envision a challenging narrative for the exercise designers and programmers to build out as an exercise.

In applying the outcomes of the MQ-9 Sim-Heavy experiment, opportunities for future research would be to identify the maximum point of effectiveness for non-UAV pilot training. This was an early attempt to work towards a simulator-only (or nearly sim-only) Initial Qualification course for a platform. As mentioned above, the remotely operated nature of the MQ-9 leans into this opportunity, which may not be as accepted for other non-remotely piloted aircraft. Regardless, opportunity exists for a broader application of the concepts of GBS, GBL and narrative into mission rehearsal and continuation training events, both in the RPA and on-craft piloted aircraft.

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