Virtual Leadership Simulator – The Missing Gap in Soft Skills Training

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ABSTRACT

The rapid improvement of virtual, augmented, and mixed reality simulators has dramatically changed how the Air Force trains Airmen in their specific technical skill sets. Some examples are pilot training, air operations training, security forces training, battlefield training, vehicle training, and medical training to name a few. Just like any other technical skills training, leadership training also requires authentic, immersive, and real-world scenarios in a safe, repeatable environment. For the past three years, Air University has explored, developed, and initiated a project to fill in the leadership development skills gap using a mixed reality simulator known as a Virtual Leadership Simulator (VLS). Because human interaction can be the most difficult to predict, the VLS uses both artificial intelligence (AI) and live actors (simulation specialists) to deliver powerful simulations using a virtual reality (VR) platform that mimic the most challenging situations military personnel face in their role as leaders. Now, the development of leadership skills and other soft skills can be practiced in the same manner the military trains personnel for hard skills training. This paper outlines the educational learning theories behind the VLS, the activities and results from the 3-year project, and implications for how the VLS can potentially revolutionize how the military uses virtual simulators.

ABOUT THE AUTHORS

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Immersive Learning Environments (ILEs), including simulations in virtual reality (VR), mixed reality (MR), and augmented reality (AR), have become a staple in military training. The advances in technology have allowed the Air Force to improve training opportunities for Air Force personnel to hone their skills in more realistic and authentic training environments. The skills Airmen require to accomplish the Air Force mission can be practiced, repeated, and developed more effectively than ever before using ILEs. The use of simulations is a powerful tool that can enhance the technical or "hard skills' of our Airmen, the most valuable asset of the Air Force. However, the Air Force seeks to develop leaders who can operate successfully in a volatile, uncertain, complex, and ambiguous environment (Currie et al., 2012). To be effective, Airmen need skills beyond their technical skill sets for their specific career field, developing not only hard skills but also interpersonal "soft skills". The Air Force Research Institute defined future leaders as possessing the following key interpersonal characteristics: ability to build teams and network with colleagues, political and cross-cultural savvy, skills at negotiation and facilitation, and emotional resilience (Currie et al., 2012). In this paper, we discuss innovations in the development of interpersonal leadership skills for future Airmen, or "leadership skills" using ILEs based on a human-in the loop model.

The use of simulations in ILEs for developing leadership skills is lacking (Guthrie, Phelps, & Downey, 2011). While hard skill acquisition and learning in ILEs is becoming quite robust, leadership development has not had the same emphasis or focus. Currently, the development of leadership skills is found predominantly through informal and formal education, presentations on topics of leadership, team building activities, leadership reaction type courses, research papers, and role-playing activities. New methods such as virtual learning environments and use of ILE simulations using virtual reality should be developed to assess leadership behaviors (Alcaniz, Parra, & Chicchi Giglioli, 2018). There has been little focus on developing simulations in ILEs that allow Airmen to practice their leadership skills in a targeted approach, similar to the use of ILEs to train hard skills. The Air Force is one of the most respected and powerful military services in the world, in large part due to the training investment in Airmen. It is time for the Air Force to leverage VR and AR capabilities to develop essential leadership and soft skills, as is done for hard skills development.

In this practitioner-oriented paper we present the concept of a new Virtual Leadership Simulator (VLS) based on simulations in an ILE for practicing leadership and other soft skills. First, we explore *human-in-the-loop simulation (HILsim)*, defined by the Department of Defense (DoD) in the *Modeling & Simulation Glossary* (2011) as a simulator "that employs one or more human operators in direct control of the simulation/simulator or in some key support function" that is used to develop leadership and soft skills. We contrast human-in-the-loop simulations with other types of simulations. Next, we provide an overview of simulation-based leadership training, describe behaviors or skill sets that can be applied in a VLS, and the educational theories that support the use of a VLS. Then, we describe a three-year project within Air University, providing qualitative data and analysis as to the effectiveness of the VLS simulator. Finally, we explore implications along with future recommendations for leadership development within the Air Force.

SIMULATIONS

Simulations are modeled based on the type of capabilities to be developed. They provide the learner a targeted opportunity to practice a certain type of procedure, skill, or behavior. In simulation the learner is provided with a safe, repeatable environment and context to gain immediate feedback on the execution of the desired skill or behavior and develop fluidity in action. Simulations provide a method of immersion and engagement creating simulated experiences and instructional methods within an immersive learning environment (Stone, 2009). Further, simulations are a way to compress a scenario or teaching skill into manageable exercises (Arenas, Clayton, & Simmons, 2019).

Human-in-the-loop simulations (HILsims) are characterized by the employment of human operators in direct control of the simulator. HILsims are human centered, "distinguished from science and process-based simulations where human intervention and modeling does not occur" (DoD, 2011). While some processes are complex and require a human to intervene, we argue the use of a human operator to provide the input into the simulation is needed when the focus of the behavior or skill requires complex interaction within the human domain, such as interpersonal skills like social networking, political savvy, and emotional resilience. In contrast, process-based simulations (PBsims) do not require human intervention and modeling. In the next section we distinguish PBsims from HILsims and highlight characteristics of HILsims which lend themselves to leadership and soft skills development.

Process-Based Simulations (PBsims)
One of the most historical examples of a PBsim in the Air Force was called the Link Trainer developed by Edwin Link (Page, 2000). The Link trainer (See Figure 1) was designed to provide a safe, real, authentic cockpit for pilot training during World War II. The pilot trainee would sit inside a mock cockpit with a control station connected to the mock cockpit. The trainee used it to practice flying a plane and completing very specific steps or procedures to ensure proper flying tactics, techniques, and procedures (TTPs). Arenas, Clayton, and Simmons (2019) described the domain of skills developed in landing a plane: a very specific process and steps to complete to ensure the safety of landing, including how much throttle, flaps, rudder, speed, and altitude at different check points in the flying pattern to be practiced. Stimuli from the simulator can create various environmental or aeronautical situations for the learner to adjust to such as landing with a cross wind. An instructor at a control station provided inputs, which in turn would create stimuli or indicators within the cockpit for the pilot trainee to address while flying the simulator. Landing the plane has very specific procedures or skills and the trainee is able to practice the specific skill set using a PBsim, and the repeatable simulation allows the trainer to practice and develop the muscle memory of a hard skill. Simulation may be fully automated or partially automated; in the latter case, the human-in-the-loop injects command-level decisions into the process and is not intended to be a "trainee" (DoD, 2011). In our example with the Link Trainer, even though the instructor pilot adjusted the input through a simulation station, to the learner the stimuli was in the non-human domain. The trainee was required to recognize a change in instrument readings based on the mechanical, electrical, or hydraulic agent input given by the instructor. When the trainee made flight corrections, the inputs were sent back to the simulation station via mechanical, electronic, or hydraulic responses. The desired end result of the Link Trainer is for the learner to become proficient in a very specific skill set; the ability to fly a plane safely from takeoff, to executing mission essential tasks while in the air, to landing the plane safely. The Link Trainer is just one example of PBsims used in the military.

Figure 1. Link Trainer

Since the invention of the Link Trainer PBsims have matured and expanded to be used in almost every career field in the military. A current example of a more advanced Non-Agent-Based Simulation (NABS) is the Air Force's move toward pilot training where student pilots use a mix of VR and AR simulators as part of their pilot training program. These types of NABS are ideal for military training. Practicing and preparing to be proficient in a specific skill set within a specific career field aligns quite well with the use of NABS that are designed for just that purpose. The ability to now add VR and AR technology to NABS has open the door for a plethora of opportunities for more advanced hard skills to be practice in military education and training settings. Some VR and AR NABS allow trainees to practice clearing a local village of insurgents, while others allow the trainee to change a tire on F-16 fighter jets. The inputs and outputs are more complicated, controlled by advanced software, 3D engines, and artificial intelligence. The end-result however is still the same – development of specific skills sets or behaviors. Even with all the improvements in technology and the added value of VR and AR, the focus of the majority of PBsims is on hard skills development.

PBsims are an excellent tool to quickly train military personnel to proficiency, and as technology improves so does the field of PBsims. This training format is one of the reasons why the United States military is one of the most respected militaries. Our Airmen, Soldiers, and Marines are given the most state-of-the-art technology to train for whatever technical skills are needed. Software, engineering, and complicated computer systems began to replace the human instructor with an *agent*. An agent is defined as "a computer system capable of autonomous action to some extent. This includes deciding for itself what it needs to do to satisfy its design objectives, and capable of interacting with other agents." While agents are increasingly used to drive PBsims processes for trainees to react to, some agents are now even capable of exhibiting human-like behavior (i.e., a 3D character, also known as a virtual human).

While sophisticated software and use of Artificial Intelligence (AI) have advanced the next generation of PBsims, including agents that can exhibit human-like behavior, there are still limitations associated with open-ended interactions needed to simulate human capabilities. Nagendran et al. (2014) argued that interrupted flow during bidirectional conversation as a result of limitations in natural language processing, such as erroneous speech recognition, repeated responses, or inappropriate language processing can detract from the simulation experience, resulting in a reduced sense of scenario plausibility, which interrupts the learning experience and in some cases may cause harm. Consequently, HILsims are used to develop human capabilities that agents and PBsims are not able to effectively simulate.

Human-in-the-Loop Simulations (HILsims)

The DoD distinguishes human-centered simulations from process-based simulations based on the role of the human instructor in the simulation. In HILsims the human operation is "in direct control of the simulator" (DoD, 2011). A human operator is needed when the learning domain is centered in complex human interactions, such as those required by armed forces leaders interacting with teams or individuals. Because of the human input, HILsims can model complex actions of the human domain, providing an opportunity for trainees to practice real-world complex social or human-to-human interactions. These types of interactions are more abstract compared to PBsims that focus on procedural or process-based behaviors. Additionally, HILsims allow the human operator to scale-up or scale-down the level of interpersonal challenge as the simulation is progressing. In other words, the rate, tone, pitch, inflection, and non-verbal communication are part of the desired skill or behavior and can be changed (scaled-up or scaled-down). This unique aspect to the type of skill or behavior within HILsims creates boundless practice scenarios, and similarly, the outcome or targeted soft skill behavior is not bound by an agent or software capabilities. The targeted soft skills or abstract behaviors found in HILsims can also be found in the application level of learning (Manton, Turner, & English, 2004) allowing students to reach the application of leadership behaviors.

Virtual Leadership Simulator

Training for hard skill acquisition is robust and is found across most functional areas within the military through PBsims, including ILEs that capitalize on innovations in VR and AR to create situational plausibility. However, the study and development of soft skills, human domain skills, and leadership skills using HILsims is not very robust and has not found its place within ILE environments such as VR and AR simulations (Guthrie et al., 2011). Developing and using ILE simulations in higher education has been fragmented to the wide array of uses of VR and AR simulations (de Freitas & Routledge, 2013). The use of educational tools within virtual worlds is an under developed approach to adult education and training (Duncan, Miller, & Jiang, 2012). Similarly, Zhang and Kaufman (2013) propose that virtual environments for educational application are still under development and researched.

Within the military, training for leadership development has the opportunity to leverage new technologies in ILEs that utilize HILsims. To capitalize on this opportunity, a protype project was conducted from 2017-2020 within Air University to develop an HILsim that allowed Airmen the opportunity to practice leadership skills. The prototype project was developed in partnership with Mursion, Inc., a VR company that develops HILsim software. The prototype was created initially for students at Air Command and Staff College (ACSC) at Air University to practice being a commander of a squadron. The HILsim that was created was termed a Virtual Leadership Simulator (VLS). The VLS is an ILE that leverages proprietary simulation software using VR and AI to amplify the human capabilities of an operator (i.e., "simulation specialist") to deliver powerful situations that mimic the most challenging interactions, scenarios, or issues faced by Airmen today. The system allows learners to interact with avatars to practice leadership skills. Avatars are digital characters in VR or AR controlled by humans (Blascovich & Bailenson, 2011). The VLS uses a hybrid intelligence model where a simulation specialist employs software to control the movement and voice of a virtual avatar (See Figure 2), combining artificial and human intelligence. On the left side of Figure 2, the hybrid model of human and artificial intelligence used to control the simulation is depicted, based on a HILsim model. The center depicts the leadership scenario comprised of avatars, environments, and performance objectives. The right side depicts the visual display where learners can participate or observe the simulation, augmenting classroom training. The VLS can also be referred to as a Mixed Reality Leadership Exercise (MRLx), Mixed Reality Exercise (MRx), Immersive Learning Experience (ILx), or Immersive Learning Simulation (ILS). Within literature, simulations such as the VLS are typically referred to as Agent-Based Simulations (ABS) and, in some cases, Live Virtual Constructive (LVC) simulations (Keeney, 2020). Next, we will explore how AI is utilized in the VLS.

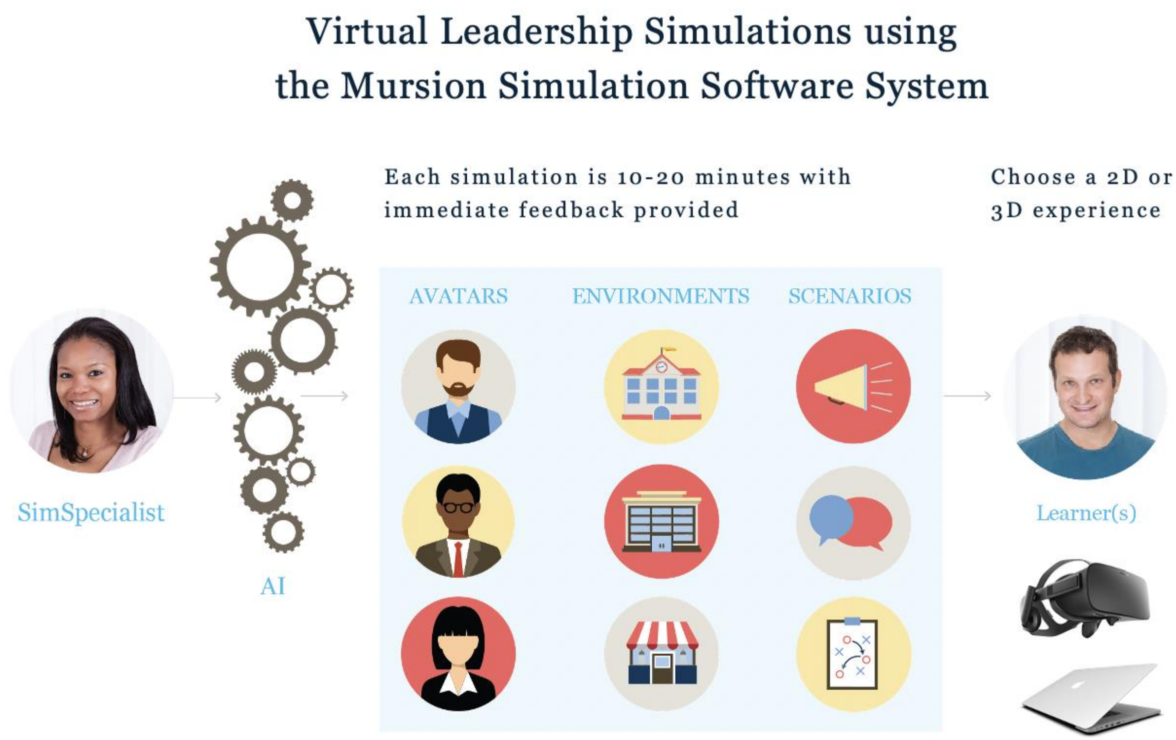

Figure 2. Visual representation of the Virtual Leadership Simulator (VLS).

Artificial Intelligence (AI) in the VLS

The use of AI technology in the VLS calls to mind applications such as big data, machine learning, deep learning, and natural language processing; however the AI employed in the VLS is used to amplify the simulation specialist's human capabilities, rather than replace them through solely software, due to the limitations described above (Nagendran et al., 2014). Through algorithmic assistance using the software system, the AI in the VLS acts as an enabler for the simulation specialist to control the leadership scenario within the VLS. This hybrid of human and artificial intelligence enables the simulation specialist to control the movement and communication (verbal and non-verbal) of the virtual avatar. In Figure 2 the simulation specialist uses specialized equipment connected to a computer that delivers input into the software. To control the avatar's movements in the VLS, the simulation specialist uses a controller, and voice morphing technology is used to give voice to the avatar. Finally, the software tracks the simulation specialist's movement to enable lifelike movement in the avatar(s). The output of the AI software enables the simulation specialist to personify any number of individual characteristics such as portraying an elderly female or a young male, including body language and facial expressions to convey emotional state. Additionally, the AI software allows the simulation specialist to control more than one avatar on the screen resulting in multiple avatars being part of the simulation scenario. The AI software used by the simulation specialist is a key part of the VLS. However, the most vital part and success of the VLS simulator is the use of human intelligence.

Human Intelligence in the VLS Simulator

The VLS simulator is an HILsim, where the simulation specialist provides the input and responses within the simulation. The process of using a human instructor leveraging AI for algorithmic assistance, such as is deployed in the VLS, is referred to as an Avatar Mediated Interactive Training and Individual Experience System (AMITES; Nagendran et al., 2014). AMITES supports the simulation specialist's performance which combines several skill-sets to include traditional acting, improvisation, and story-telling using a computer interface (Nagendran et al., 2014). This process has also been described by Nagendran et al. (2014) as digital puppetry. What the simulation specialist says, thinks, feels, and does is mimicked into the simulation resulting in the virtual avatar displaying authentic human behaviors in an immersive live setting. This unique use of a human operator to control the inputs and responses into the simulation through a virtual avatar creates a new opportunity to expand the use of simulations from technical skills development to the human domain of leadership skills development. By incorporating AI and human intelligence together it creates a suspension of disbelief or sense of presence in the moment within the trainee, lending to the authenticity of the scenario (Nagendran et al., 2014).

Suspension of Disbelief

HILsims, especially like the VLS, draw on a unique human proclivity to anthropomorphize inanimate objects (Duffy & Zawieska, 2012). The desire to allow one's mind to develop social interaction with an inanimate object such as a machine or in the case the VLS through a virtual avatar is known as suspension of disbelief. Suspension of disbelief has appeared in many settings other than simulations, literary works such as poetry, where the reader suspends disbelief of supernatural or non-realist elements in order to enjoy the poem (Duffy & Zawieska, 2012). The VLS simulator uses anthropomorphism or the ability to imitate life to allow the trainee to believe that the virtual avatar itself is a real person, with real life issues. In the previous paragraph the term digital puppetry was introduced. Puppeteering provides the foundational concept and research of why trainees within the VLS are able to create a suspension of disbelief resulting in trainees practicing the most complex human domain skills. Using the model of puppeteering, we can extrapolate that the same elements found in puppeteering for suspension of disbelief to be seen in digital puppetry found in the VLS. In the VLS, the simulation specialist controls a virtual avatar similar to a puppeteer who controls a physical puppet. The puppet or virtual avatar puppet in our case creates the illusion of life in order to depict some aspect of reality (Duffy & Zawieska, 2012). There are several factors of puppeteering that makes this illusion of life possible that can be translated to advanced virtual puppeteering that is being accomplished by the simulation specialist within the VLS.

Physical design is the first factor that allows for the suspension of disbelief to occur within the VLS simulator. Duffy and Zawieska (2012) suggest that the eyes are the most important aspect of puppeteering. Eyes play a crucial role in the connection between two people. In this case the virtual avatars ability to create character through the eyes produces a universal representation of the human being (Duffy & Zawieska, 2012). Mouth movement also plays a role but is not as important as the eyes, because the trainee can use other physical cues such as head movement of the virtual avatar to fill in the physical traits associated with a real person (Duffy & Zawieska, 2012). The software system uses input from equipment to track the natural movement of the simulation specialist which is then mimicked through the virtual avatar. This tracking equipment, along with the avatar controller, allows the simulation specialist to control different body movements through behaviors, such as squinting eyes or eyes widening to represent surprise, thus elements of the AI software support how physical design of virtual puppeteering creates an illusion of life.

Motion is the second factor that creates a sense of life in the virtual avatar. The motion or movement of the virtual avatar must match and be coherent with the character of the virtual avatar and the social context that is occurring within the simulation. For example, if the simulation specialist is trying to portray disagreement with the trainee, then the movement of the avatar must be able to represent disagreement verbally but also physically such as the virtual avatar's head being able to turn and look away, or the avatar's arms being able to cross to show the trainee that the avatar is being closed off. If the virtual avatar wants to show interest, the avatar needs to be able to lean in or lean forward, or nod his or her head up and down in agreement. These non-verbal physical cues are necessary to produce social contextual elements that align with the verbal conversation that is occurring within the simulation. Through motion, the trainee can connect and relate to the virtual avatar in a more realistic and authentic enviornment and becomes immersed in the real issue that the avatar is displaying. As a result, complex social situations can be practiced, thus resulting in a simulation that allows for the practice within the human domain.

Speech is the third factor that a virtual avatar puppet must be able to demonstrate to create suspension of disbelief. The ability for the simulation specialist to modulate paralinguistic features such as tone, rate, pitch, rhythm, dialect, etc. helps the trainee to build a belief system that the virtual avatar is a real person (Duffy & Zawieska, 2012). Within the VLS this is done through voice modulation software which allows the simulation specialist to change the paralinguistic settings as well as techniques applied by the simulation specialist through professional vocal characterization. The ability of the simulation specialist to use speech to simulate a real conversation can be described as authentic dialogue within the VLS. Dialogue supports the concept of suspension of disbelief, as opposed to agent-driven simulations that contain text-dependent communication (e.g., branching scenarios with multiple choice options). When the trainee engages in rich, full, and intimate communication with the avatar, a more interconnected "relationship" is developed between the virtual avatar and the trainee. This deeper, richer form of dialogue allows the VLS to build scenarios that require a practice in human capabilities to occur. What the trainee says and more importantly how the trainee responds through dialogue influences what and how the virtual avatar will respond.

This back and forth dialogue is at its essence a practice in human capabilities where there is no right or wrong answer or approach to dealing with the scenario presented to the trainee. In fact, using one simulation scenario and having multiple trainees each execute the same scenario, the approach or means by which the trainee addresses the issues within the scenario will be different for each trainee. By combining the use of AI as algorithmic assistance for the simulation specialist to create suspension of disbelief based on the factors described above, a given scenario or issue can be addressed multiple ways based on the live, authentic, real dialogue between the virtual avatar and the trainee. Based on the trainee's personality, experiences, emotions, biases, etc., the trainee will pull on these elements to navigate the dialogue with the virtual avatar and display authentic behaviors that the trainee would normally display.

This practice of authentic behaviors is termed "real-play". The term "real-play" describes both the suspension of disbelief within the trainee's mind and the act of practicing authentic behaviors in a safe, immersive, and repeatable enviornment. Real-play is quite different than "role-play". Role-playing requires the individual or trainee to take on a role and assume the other participant is playing a part in a scenario that is not realistically the true character of that participant. Role-playing or peer modeling is a low risk method for practice modeling however, the impact of learning is limited by the learner's skill level in the role-playing exercise (Buckridge, 2016). For example, if two participants are role-playing where one participant is playing the role of a female (participant A) who just had a baby and the other participant is their supervisor (participant B), participant B may not be able to suspend disbelief that participant A actually just had a baby and is now struggling with postpartum depression. The reason participant B may not suspend disbelief is because participant A maybe their fellow classmate and they know their fellow classmate has not had a baby, so participant B cannot connect with or believe in the context of the scenario. This is the challenge with role-playing. In role-playing there is limited authenticity or connection by the participant to get to the suspension of disbelief, the scenario does not feel real because the other participant in the role-playing activity is a person that is already part of participant B's enviornment and participant B cannot disassociate the fact that participant A is now someone else or is a different character in a different life situation. Additionally, participant A may not know how to demonstrate what it feels like after having a baby. Participant A may not know what postpartum feels like and therefore cannot authentically demonstrate that in the role-playing activity resulting in participant B not believing in the role scenario and will not demonstrate authentic behaviors in the role-playing activity. Furthermore, what if there are no female students in the group to play the role of participant A (a woman who just had a baby and has signs of postpartum depression)? How is the learning activity to proceed? The limitation abilities of the participant in role-playing impede the effectiveness of the realistic practice of authentic behaviors (Rees Dawson & Lignugaris-Kraft, 2013). Role-playing can be effective, however a better educational approach using a mixed-reality virtual simulation alleviates the need for role-playing and creates a more authentic learning activity called real-play.

Real-play is a new paradigm in the simulation field, especially when the simulation's outcome requires the participant to display soft skill or human domain behaviors. The elements of advanced electronic puppeteering create a sense of a real-life social context which the participant can anthropomorphize in their mind an illusion of real-life human to human dialogue. This practice of soft skills in a mixed reality simulation or virtual rehearsal is only successful if the VLS can create human action and psychological responses that are shaped by the simulation specialist through suspension of disbelief (Nagendran et al., 2014). The end result is the ability to create open-ended real life, ambiguous, ill-defined, complex problems that requires a vast array of soft skill behaviors to deal with or manage. The result is a mixed reality environment that allows the learner to engage in real-play or authentic behaviors. This combination of AI software, human intelligence (simulation specialist) and the elements of advanced puppeteering creates an experiential learning environment within in the VLS. The use of technology such as virtual worlds, VR, AR, and mixed reality environments do not create the learning experience per se for the learner. Learning occurs when educational theories are aligned with how technology is used to reach those educational learning theories. Next, we will explore the learning theory that undergirds the use of the VLS as an ILE.

Experiential Learning

Experiential learning or the Experiential Learning Theory (ELT) provides an adaptive approach to learning, where experience, cognition, and behavior change are the elements required for experiential learning (Clayton, 2017). Experiential learning is a foundational learning theory used in leadership development immersive learning activities (Priest & Clegorne, 2015). Experiential learning uses real-world scenarios or experiences so learners can reflect from those experiences, and then make adjustments or create new behaviors based on the previous experience and reflection. More specifically, experiential learning can be broken down into four stages (DiFrancesco, 2011; Guthrie, Phelps, & Downey, 2011; McCarthy, 2010; Stone, 2009) which are; (1) experience or experimenting (2) reflective observation or observing (3) abstract conceptualization or reviewing (4) active experimentation or action planning. This four-stage process can also be described as experiential triangulation through (1) experimentation (2) cognition (3) behavior change.

Within virtual worlds such as the VLS, the type of experience is very important to the success of the VLS. There are four types of experiences and all four types can be found in the VLS which are (a) concrete experience (b) individual experience (c) social experience (d) abstract experience. Experiences are created when the learner has a physical, emotional, or psychological connection to an event that the learner just experienced. Experiences can take the form of positive and negative physical, emotional, or psychological connections. The VLS is designed so that the learner has the opportunity to navigate through each type of experience.

Once the learner has been provided an experience, reflection, introspection, and feedback must follow, this is the second stage in the experiential learning model, known as cognitive reflection. Reflection is required to ensure the learner has the opportunity to develop an understanding of what occurred, how the scenario in the simulation was executed, and most importantly, why the simulation proceeded forward based on inputs and outputs into and out of the simulation. Reflection within the experiential learning model can come in three forms, (1) content reflection (2) process reflection (3) premise reflection. Cognitive reflection through content, process, and premise reflection is key to the experiential learning process. Feedback and coaching are two techniques found in the reflection stage of experiential learning. According to Hattie and Temperly (2007) feedback is determined to be the most powerful modification that enhances a learner's performance and deep learning. Research indicated immediate performance feedback on errors during task acquisition resulted in faster rates of acquisition, while delayed feedback enhanced deeper learning (Hattie & Temperly, 2007). The goal of feedback during the experiential learning process is to close the gap between performance and the desired goal (Buckridge, 2016). Without reflection and targeted feedback after the execution of an experience (at the end of a simulation), the learner would not be able to process the behaviors the learner demonstrated or introspect about what behaviors the learner did well, did not do well, or did not demonstrate that were needed. The use of experiential learning provides a framework for adult learners to experience, reflect, and develop new behaviors such as leadership skills (Guthrie & Jones, 2012). By combining the VLS with experiential learning a pilot program was developed to assess the effectiveness of using VR, AR, and mixed reality environments in educational settings for leadership development.

VLS SIMULATOR PILOT PROGRAM

In 2017 a collaboration effort began to research VR, AR, and mixed reality environments that could help improve the educational learning outcomes that focused on the application of leadership within Air University (AU) Professional Military Education (PME) programs. The end result was the development of partnerships with local institutions of higher education, an organization in the corporate sector, seven Air University schools and organizations, and four different Major Commands (MAJCOMs).

Initially the pilot program using the VLS started with a small group of elective courses within the Air Command and Staff College (ACSC) at Air University. Several instructors and professors volunteered to incorporate the VLS into the ACSC electives such as “Toxic Leadership”, “Mentoring and Coaching”, “The Psychology of Leadership”, and “The Command Elective”. However, once the funding was approved, the pilot program had enough funding to expand the prototype from using it in the ACSC elective program to using the VLS for every ACSC seminar during the first year of the pilot program. With this effort the VLS went from approximately 60 ACSC students executing the simulator, to 499 ACSC students being a part of the initial prototype. In the first year, the VLS executed more than 213 simulation hours at a cost of $32,000. The simulator was divided into two-hour simulation blocks where 12 ACSC students executed the simulation. This setup allowed more than 40 simulation events to occur over a 3-month period. During this time-frame, more than 10 different leadership scenarios were developed for the initial prototype project. Within those 10 VLS scenarios, four scenarios were identified as signature scenarios that became the backbone for the VLS and were later integrated into 7 other Air University schools and organizations.

The VLS was so successful in the first year as a prototype for ACSC that it was incorporated into the curriculum development of the full Leadership Course within the Department of Leadership at ACSC. The incorporation of the VLS into a Master’s Degree accredited program solidified and validated the effectiveness and use of the VLS, that several other Air University courses and programs requested initial prototyping and use of the simulator as well. Moving from year one of the prototype to year two increased the use of the VLS from one education course, to more than 10 separate courses at Air University. Additionally, three additional MAJCOMs joined in partnership to further expand the prototype use outside of Air University courses, but also to other professional development and professional training courses offered throughout the Air Force. Those MAJCOMs included Air Combat Command (ACC), Air Education and Training Command (AETC), Air Force Reserve Command (AFRC), Air Force Materiel Command (AFMC), and Air Force Special Operations Command (AFSOC). Below is a list of those organizations and courses who used or utilized the prototype during the second and third year of the pilot program.

- ACC Commander’s Course
- ACC Sword Bearer Course (Enlisted Course)
- ACC Sword Look Course (Captain Course)
- ACC Sword Forge Course (Civilian Course)
- Eaker – Wing Command Chaplain Course
- Eaker – Judge Advocate General School
- Eaker – Leadership Development Course
- AETC – 82 TRW – Mx Trng Cert Course
- AFRC – Chiefs Development Course
- AFMC – Senior Leader Orientation Course
- Air University – Research Task Force
- Joint Base McGuire–Dix–Lakehurst Flt/CC Edge Crse
- ACSC Elective Program
- ACSC Mega Command Elective
- Eaker – Basic Chaplain Course
- Eaker – Deputy Command Chaplain Course
- Holm Center – OTS Instructor Course
- Holm Center – ROTC
- Holm Center – ROTC Instructor Course
- Barnes Center – Chiefs Leadership Course
- Barnes Center – SNCOA Academy
- AFSOC – Equal Employment Opportunity Course
- AFSOC – Sexual Assault Response

Eaker Leadership Development Course (LDC)

In 2018, the Eaker Center for Leadership Development at Air University, developed a Leadership Development Course (LDC) based on guidance from the Chief of Staff of the U.S. Air Force (USAF) and the 2018 RAND Report which suggested the need to improve the effectiveness of Air Force Squadron Commanders (Ausink, et al., 2018). The LDC is an intense eight-day course that uses a mix of lectures, seminars, and experiential activities. The LDC focuses on the human domain and leadership skills using multiple active based learning activities culminating in a capstone event using the VLS. Since 2018, more than 2,000 officers and civilians have graduated from the LDC

Course. During the first year, faculty from the LDC initiated a study to assess and measure the impact of the course. The study included more than 280 students using a three-stage qualitative approach measuring the area of impact, the level of impact, and the depth of impact the course had on the LDC students. One of the findings from the study that focused on the area of impact on students indicated students' response to which course topics were the most effective during the LDC. According to Hinck and Steve (2018), LDC students ranked the VLS as the fourth most effective topic within the LDC out of 26 possible topics. The response rate for this study was a 92.7% response rate (308 out of 332 student response). Additionally, a follow up study was conducted with a second cohort of students with a response rate of 97.26% where students ranked the VLS as number two out of 31 topics. The VLS has been so successful, that the LD faculty have initiated their own contract to continue to use the VLS in the LDC.

Air Combat Command (ACC) Developmental Courses

Air Combat Command (ACC) was the first Major Command (MAJCOM) that joined the partnership to expand the VLS to other developmental courses outside of Air University. ACC Career Development Branch (ACC/A1KB) began to schedule the VLS into four of the ACC's developmental courses, including the ACC Squadron Commander's Course, ACC Captain Course (Sword Look), ACC Enlisted Course (Sword Bearer), and ACC Civilian Course (Sword Forge). Since 2017, more than 400 ACC Airmen have participated and executed the VLS. To ensure the prototype was meeting the outcomes of the ACC courses, the ACC staff gathered end-of-course feedback specifically requesting feedback on the use of the VLS and the effectiveness the VLS had on the development of practicing the behaviors of coaching and feedback to others. ACC captured feedback from nine separate ACC courses (five from the ACC Commander's Course, three from the Sword Look Course, one from the Sword Bearer Course, and one from the Sword Forge Course). Below is a compiled list of comments from all four ACC courses.

- "This was hands-down the best feedback I have experienced in my 20+ years of service."
- "This was a great tool to help leaders experience the challenges of interpersonal dialogue under pressure."
- "Phenomenal, such a great tool to practice people skills in the moment"
- "This was unlike anything I've ever seen! I would love to see this implemented around the Air Force."
- "Excellent program should be used Air Force Wide."
- "It was very interesting and helpful. Providing the avatar allowed us to simulate real people creating a real-life scenario."

Chaplain College

The Chaplain College within the Eaker Center for Leadership Development also initiated use of the VLS across three of the Chaplain College courses. From 2018-2019, more than 300 students in the Basic Chaplain College (BCC) course, Deputy Wing Chaplain (DWC) course, and the Wing Chaplain (WCC) course participated and executed the VLS. During the BCC, DWC, and WCC course 2019 "Alpha" courses, faculty and staff gathered a small set of data to assess and evaluate the usefulness and effectiveness of the VLS. The first question the faculty and staff asked their students was to rate the before and after positive effect the VLS had on the counseling scenarios encountered during the VLS. Students responded with a 59% major effect, 28% moderate effect, 5% neutral effect, and 1% minor effect on students' personal experience with the VLS. The level of importance for Chaplains to experience counseling training scenarios using a mixed reality environment indicated that 69% responded saying the level of importance is extremely important to experience a counseling scenario using a mixed reality simulation. Chaplain students also indicated that 74% strongly agree that the use of the VLS used for counseling training adds value to the overall courses within the Chaplain College. Additionally, 81% of students reported that the use of the VLS should be a priority for all students to execute and not just be an observer during the simulation. Chaplain College students also provided qualitative comments about their experiences in the VLS. Several of those comments are listed below.

- "This was life changing equipping us with this high level of awareness."
- "Nothing but learning training and inspiration for the troops."
- "Very skeptical at first…now I'm a huge support…this is fantastic."
- "Best learning lab ever experienced."

Summary of VLS Pilot Program

The VLS pilot program has been tremendously successful at demonstrating the flexibility, and ease of use of the VLS across multiple organizations in the Air Force. The VLS has proven to be successful at all levels of officer, enlisted, and civilian education developmental courses. The simplicity of the VLS has allowed scenarios to be applied across a wide spectrum of leadership challenges. Additionally, the VLS has been tested in small groups (as little as 1-2 people) and in large groups (up to 400 people) at one time in a simulation setting. Location of the VLS has also been tested. As long as the physical location for the simulation has access to Wi-Fi when using a laptop, then the simulation can be used virtually anywhere. Similarly, the VLS can be executed on a mobile smart phone or tablet making the accessibility to use the simulation extremely easy to access. During the coronavirus pandemic (COVID-19), many of our educational partners' courses were cancelled and could no longer offer their course work to military personnel in a physical classroom. The VLS however is quite flexible and can use virtual mediums such as Zoom which allowed several Air Force organization's courses to re-design their courses while still using the VLS. This has expanded the ability for virtual courses to also reach the application level of leadership skills development using the VLS.

Theoretical and Practical Implications

The use of an HILsim in a mixed reality ILE has changed the paradigm of how simulations can be applied within education and training programs. The application of leadership skills using advanced virtual puppetry creates a sense of suspension of disbelief allowing the learner to interact in a virtual enviornment while applying authentic leadership skills. Combining adult learning theories such as experiential learning, a unique ILE can be created using the VLS. The use of experiential learning allows the learner to engage in experimentation, reflective thinking, social interaction through cognitive, behavioral, and virtual environmental influences and authentic real-world situations in a virtual mixed reality environment (Kratzke & Bertolo, 2013; Jacob, 2012). The VLS creates a real experience for the learner allowing the learner to engage in real-play supported by the educational learning theory that takes the experience from the simulation and codifies that experience into reflective learning and future changes in behavioral skills, thus meeting the definition of development; a change in behaviors.

Recommendations for the Future

The combination of this HILsim and educational learning theory is an innovative approach to the application of simulations in military education and training programs. The VLS through the lens of an ILE closes the skills gap within the field of simulations as it pertains to leadership skills. However, operationalizing the VLS into military education and training programs is still under developed. The prototype over the past three years has grown from one PME school and one MAJCOM to more than 7 PME schools and four MAJCOMs impacting the leadership development for more than 7,000 Airmen. However, leadership development must be a cradle to grave approach requiring resources and a focus on leadership development to be much more deliberate. This requires a focus and attention on simulation development for leadership skills and a leadership simulation center for the Air Force. The authors recommend the creation of a leadership simulation center within Air Education and Training Command (AETC), Air University, Eaker Center for Leadership Development. An expansion of the VLS should be incorporated as a larger prototype within the Eaker Center for Leadership Development. This would allow other Air Force organizations to test the use of the VLS for officer, enlisted, and civilian personal and professional development. The Air Force Agency for Modeling and Simulation (AFAMs) has provided additional funding for the fiscal year 2021 to allow the Eaker Center for Leadership Development to continue this effort and help to spur additional partnerships and collaboration with other Air Force organizations to ensure the Air Force is using the most current and relevant technology to ensure the leadership development of Airmen. The VLS is the first step in the potential growth and paradigm shift in how simulations are used across the Air Force, and has the potential to close the gap on leadership skills, opening the Air Force to a new level of leadership development that in the past was difficult to achieve with Airmen. Leadership development in the form of a virtual mixed reality simulation can change the paradigm of simulations and leadership skill development for the Air Force.

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REFERENCES

Alcañiz, M., Parra, E., & Chicchi Giglioli, I. A. (2018). Virtual reality as an emerging methodology for leadership assessment and training. *Frontiers in psychology*, *9*, 1658.

Arenas, F. J., Clayton, A. S., & Simmons, K. D. (2019). Make It Real: Presence and Immersion in Simulation Design. In *Recent Advances in Applying Identity and Society Awareness to Virtual Learning* (pp. 126-137). IGI Global.

Ausink, J.A., Matthews, M., Conley, R. E., & Lim, N. (2018). Improving the effectiveness of air force squadron commanders: Assessing squadron commander responsibilities, preparation, and resources. Santa Monica, CA: RAND Corporation

Blascovich, J., & Bailenson, J.N. (2011). Infinite Reality - Avatars, Eternal Life, New Worlds, and the Dawn of the Virtual Revolution. New York: William Morrow.

Buckridge, H. (2016). Mixed Reality Experiences in the M. Ed. Educational Leadership Program: Student Perceptions. de Freitas, S., Routledge, H. (2013). Designing leadership and soft skills in educational games: The e-leadership and soft skills educational games design model (ELESS). *British Journal of Educational Technology,* 44(6), 951-968.

Clayton, A. S. (2017). *Multiplayer Educational Role Playing Games (MPERPGs) and the Application of Leadership* (Doctoral dissertation, Grand Canyon University).

Currie, K., Conway, J., Johnson, S., Landry, B., Lowther, A. (2012). Air Force leadership study: The need for deliberate development. *Air Force Research Institute Research Paper 2012-1.* Air University Press: Maxwell Airforce Base, AL.

Department of Defense. (2011). Modeling and Simulation (M&S). Alexandria, VA: Modeling and Simulation Coordination Office.

de Freitas, S., Routledge, H. (2013). Designing leadership and soft skills in educational games: The e-leadership and soft skills educational games design model (ELESS). *British Journal of Educational Technology,* 44(6), 951-968

DiFrancesco, P. (2011). *The role of situated learning in experiential education: An ethnographic study of the knowledge-construction process of pharmacy students during their clinical rotations*. University of Massachusetts Boston.

Duffy, B. R., & Zawieska, K. (2012). Suspension of disbelief in social robotics. In *2012 IEEE RO-MAN: The 21st IEEE International Symposium on Robot and Human Interactive Communication* (pp. 484-489). IEEE.

Duncan, I., Miller, A., & Jiang S. (2012). A taxonomy of virtual world's usage in education. *British Journal of Educational Technology,* 43(6), 949-964.

Guthrie, K. L., Phelps, K., & Downey, S. (2011). Virtual worlds: A developmental tool or leadership education. *Journal of Leadership Studies, 5*(2), 6-13.

Guthrie, K. L., & Jones, T. B. (2012). Teaching and learning: Using experiential learning and reflection for leadership education. *New Directions for Student Services*, 2012(140), 53-63.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81–112.

Hinck, J., & Steve, X., (2018). Re-Operationalizing and Measuring "Impact" of a Leader Development Course. *International Journal of Teaching and Learning in Higher Education.*

Jacob, L. B. (2012). Using virtual worlds to identify multidimensional student engagement in high school foreign language learning classrooms (Order No. 3546116). Available from ProQuest Dissertations & Theses Full Text: The Humanities and Social Sciences Collection. (1242091888).

Kratzke, C., & Bertolo, M. (2013). Enhancing students' cultural competence using cross- cultural experiential learning. *Journal of Cultural Diversity, 20*(3), 107-111.

Keeney, M. J. (2020). Blended-Reality Training: A New Approach to Simulations. *TIP: The Industrial-Organizational Psychologist*, 1–6.

Manton, E., Turner, C., & English, D. (2004). Testing the level of student knowledge. *Education, 124*(4), 682-687.

McCarthy, M. (2010). Experiential learning theory: From theory to practice. *Journal of Business & Economics Research, 8*(5), 131-139.

Nagendran, A., Pillai, R., Kavanaugh, A., Welch, G., & Hughes, C. (2014) A unified framework for individualized avatar-based interactions. *Presence: Teleoperators and Virtual Environments*, *23*, no. 2: 109–132.

Page, R. L. (2000). Brief history of flight simulation. *SimTecT 2000 Proceedings,* 11-17.

Priest, K. L., & Clegorne, N. A. (2015). Connecting to experience: High-impact practices for leadership development. *Discoveries*, 71-83.

Rees Dawson, M. & Lignugaris-Kraft, B. (2013, May). TeachLivE™ vs. role-play: Comparative effects on special educators’ acquisition of basic teaching skills. Presentation at the 1st National TeachLivE™ Conference, Orlando, FL.

Stone, S. J. (2009). *Instructors' perceptions of three-dimensional (3D) virtual worlds: Instructional use, implementation and benefits for adult learners* (Ed.D.). Available from ProQuest Dissertations & Theses Full Text: The Humanities and Social Sciences Collection. (304964522).

Zhang, H., & Kaufman, D. (2013). Virtual environments in education: Developments, applications and challenges. *International Journal of Computer Research, 20*(1), 123-141.