AIR UNIVERSITY

LEARNING IN IMMERSIVE VIRTUAL REALITY

Prototyping the future of learning

INTRODUCTION

Immersive virtual worlds are proving well suited platforms for scientific and educational experimentation, exploration, evaluation, brainstorming and propositional test and evaluation trials. The included materials describe the work of innovation with the use of immersive virtual worlds by the A4/6I Innovations and Integration Division team at Air University. The emergence of this highly innovative and interactive technology offers educators across the spectrum great opportunities to enhance traditional instructional methodologies because a closer fit can be designed into the linkage between immersive virtual worlds and how people prefer to learn and interact socially within and across communities of practice (as suggested from research on the connections between human cognition and the sociology of learning and performing[1]).

The twelve prototype learning environment designs, depicted in this pamphlet, were stewarded by the Air University A4/6 Innovations and Integration Division team in collaboration with Air University faculty and other educators from across several universities. The chart below is a sampling of potential uses of immersive virtual worlds to enhance, learning and performance in an organization.

Technology	Process	People
• Provide access to technological capabilities that may not be affordable or readily accessible in the physical world due to cost, locality, proximity, and distance constraints. • Offers opportunities for sharing, linking and mixing the best of physical and virtual technologies across training, education, and performance-support environments. • Enhances the ability to leverage and scale technological innovations in terms of cost and time to implement or modify, with increased accessibility.	• Can support processes involving the mixture or blending of virtual and physical workflows, systems, and organization structures (e.g., combination/integration of paper and electronic document management processes, virtual and physical office hours, support/service activities, data exchange and interoperability, real-time process analytics across virtual and real-life work environments, virtual rapid-prototyping, product design, development, testing, and implementations). • Can provide global and distributive connection/outreach for using 3D benefits in support of complex operation processes, decision-and performance support systems (e.g., distributed combinations of real and remote-controlled craft, collaborative remote instrumentation and procedures (e.g., surgery, research).	• Can provide the means or support for social-learning environments that are more closely aligned to real-life by recognizing the value people place on interactivity and richly-laden stimuli in the form of multiple and diverse visual and auditory sensory inputs. • Can reduce artificial-environment induced disbelief by providing high-end (quality design) immersive tele-presence capabilities; this can strengthen the role and power of affect for enhancing learning and performance, enhancing believability and valuing of effort/outcomes, thus making for a closer alignment between the environment and how the brain associates, codes and processes information (e.g., see research on situated cognition and environmental context-dependent memory).
Creativity	**Collaboration**	**High-risk Prototyping and Immersive-Experiential Learning**
• Can provide 3D tools and landscape for creating and linking both imaginary and life-like features (the	• Can offer similar or improved advantages over standard web-based collaboration tools wherein	• Can offer the means for engaging users with high-risk prototyping and experiential learning activities

[1] For an excellent summary of the research see: Bransford, J., et. al., (2000) and Wenger, E. (1998).

blending of art and life) for exploring the art of the possible. • Can open up new ways of thinking from exposure to diverse cultures, different perspectives, and practices outside of existing community, domain, or culture.	virtual meeting and learning spaces are coupled in near-seamless ways with synchronous and asynchronous data sharing and communication tools. • Can be used to broaden network of collaborative expertise, and improve access to requisite variety of experts, within and across domains situated in context of challenge or environment.	wherein failure does not result in the loss of life or equipment; also can help with intersecting disciplines (e.g., language and culture) into immersive scenarios (see next point below). • Can offer immersive capability in support of life-like scenario and experientially-based learning activities and challenges (e.g., using anchored-inquiry instruction methods) for developing higher-order knowledge and skills associated with the development of critical-thinking and advanced problem solving.
Place/Identity/Community Presence & Continuity of Experience Within Community	**Collectiveness**	**Semantic Enrichment**
• Can help foster a sense of place, identity, and community presence over longer periods and across multiple real-life workplace changes and locations for lifelong continuity of practice where the landscape can consist of both physical and virtual geography or mixed combinations (Note: people susceptible to identity diffusion, dislocation feelings and/or proclivity towards an inability to distinguish between real and imaginary facets may be at increased risk with the use of virtual worlds over extended periods of time; there is currently little research on the nature of this risk or the relationship of the risk to developmental levels of people).	• Can help with forming reciprocal (or mutual engagement) action-oriented relationships and activities across levels of creativity, collaboration and social networks regardless of geophysical location, organizational structures, and institutional affiliation. • Can help support collective intelligence (via both implicit and explicit means) and give people greater opportunity to practice the construction of knowledge using visualization, media sharing, and game-playing tools situated in context and linked via relationships in virtual space.	• Can provide for more powerful ways to define, link, interpret, and visualize data and to integrate data into increasingly powerful knowledge structures and systems.[2] • Can help people change the organizing principle of visualized data and knowledge from across products, process, people or concepts, and their connections, to form a more complete picture or understanding of a topic.

Collectively, the propositions presented in the above table should be considered factors in the design and use of immersive virtual worlds to enhance learning and performance. Also, anticipated benefits are more likely if immersive virtual world propositions are appropriately blended with real-world learning and performance support environments and aligned with the organization, processes, and technology. The use of immersive virtual worlds for interactive and collaborative teaching and training purposes is not longer just a possibility; it is reality.

[2] For additional information see Shadbolt, Nigel & Berners-Lee, Tim (2008, Oct). Web science emerges. *Scientific American*, pp. 76-81.

LEARNING IN IMMERSIVE VIRTUAL REALITY

Meredith Bricken (1991) and Hilary McLellan (1991) argued immersive virtual reality (see Lanier, 2001) can be very supportive of situated and constructivist learning. Immersive virtual reality provides the means for a person to enter a virtual spatial multi-sensory environment and embody it in such a way as to actively inhabit, interact, and create the next event (Bailenson, et. al., 2008 and Walser, 1992).

According to Bricken (1991) immersive virtual reality learning environments can be designed to be experiential and intuitive; providing learners with control over time, scale, and physics for a shared experience and information context supporting interactive hands-on learning, group projects and discussions, field trips, simulations, concept visualization, and to observe from many perspectives. Prototypes of immersive virtual reality learning environments, constructed by Air Force researchers and learners for assessing differences between classical and future designs, are illustrated across the Air Force immersive virtual reality regions in Second Life (see http://secondlife.com).

One set of the prototypes depict classical-oriented, learning environment designs. Recognizable visual cues of social roles for instructors and learners, interactive learning tools (e.g., virtual computers, plasma screens, and books), auditory features, help to establish a sense of a situated place supporting classical learning environments. Digital immigrant learners are more likely to recognize and accept the validity of the classical-oriented designs as suitable places for situated learning.

Various future-oriented, immersive virtual reality learning environment designs are also represented in the Air Force regions. The future designs offer affordances or opportunities for action (learn by doing), bundled together with learning tools and devices. Also, the future designs provide surrogate settings of actual work environments supporting apprenticeship, collaborative teamwork, coaching, and monitored performance feedback.

Visitors to the Air Force regions can take a tour to visit each prototype and provide feedback on the designs. Feedback is used to examine each design and improve on future prototypes and implementations for operational use. Each of the learning environment prototype designs are described and depicted on the following pages.

Learning Environment Prototype: Study Group

The Study Group prototype was designed to place emphasis on relational aspects associated with learning. The space, while elegant, is utilitarian in scope wherein relationships in learning can be nurtured amid a serene, dim, and contemplative interior. Crossing into the room from the entrance conveys an image of calm enclosure and of seeping light. Wrightian interior spaciousness is central to the design. The furniture in the study group area conveys a sense that they are built-in as part of the original scheme considering the whole as a unit. The fireplace is at the heart of the room, around which furniture is arranged but toward which attention always is drawn back.

Learning Environment Prototype: Seminar

The Seminar prototype conveys an interior learning design that is cozy while also suggesting a disciplined perspective with the placement of room artifacts and attention to detail. A higher information or stimuli load is given to consider with the plasma screen. The space also suggests an environmental psychology principle in how learners can be situated in a shared space for enhancing approachability with the seminar leader or facilitator.

Learning Environment Prototype: Auditorium

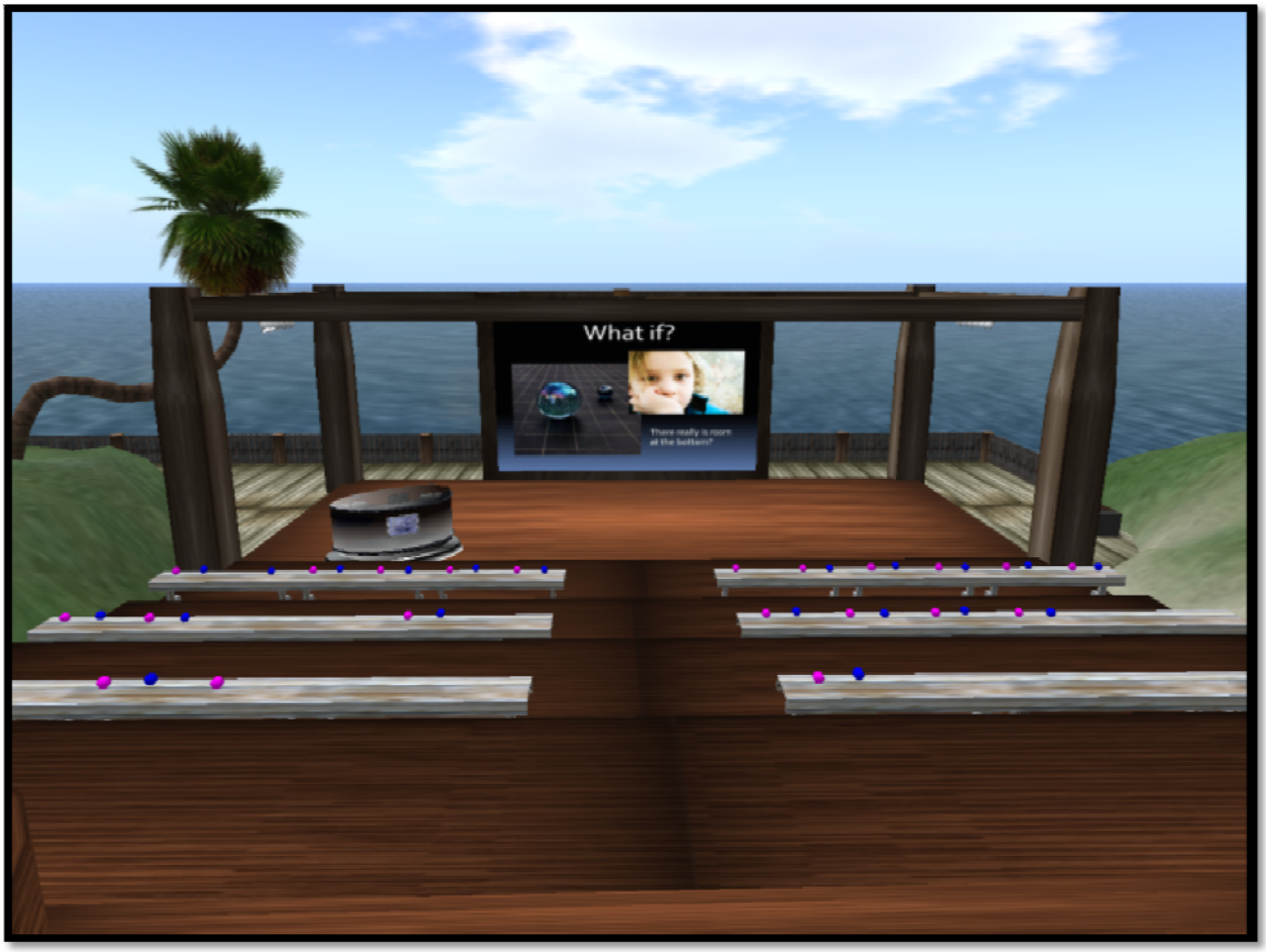
The Auditorium prototype was designed to place greater emphasis on instructional function rather than form. The learner seating space by aisle is dense. The use of a stage, with a podium, suggests authority in the learning environment. Emphasis on aluminum, and ribbon windows, in the design suggests a machine-inspired aesthetic of European modernism. There is also a touch of neoclassical influence with the carved paneling and doors suggesting a touch of historicism blended into an eclectic atmosphere for learning. The glass ceiling offers semi-transparency with a suggestion of physical protection.

Learning Environment Prototype: Lecture Hall

The Lecture Hall prototype creates a ceremonial atmosphere for learning. The placements and sizes and heights of learner chairs, with an open walkway in the center of the room, suggest a judicial environment wherein arguments are presented and dissected with formal Socratic rhetoric. The heavy paneled walls are an embodiment of the classical orders to create a strong masculine-oriented learning environment.

Learning Environment Prototype: Amphitheater

The Amphitheater prototype bridges theater with learning in an antiquarian environment. Acceptable sight lines towards the stage are provided for learners. The design is stage front in the traditional Renaissance convention. The symbolic frontal stage design is the marker of instructional power involving deferential status of the instructor-learner relationship. Standing yards are present on each side of the stage in 16th-century tradition as places where stories could be told and listened to without the distraction of elaborate sets.

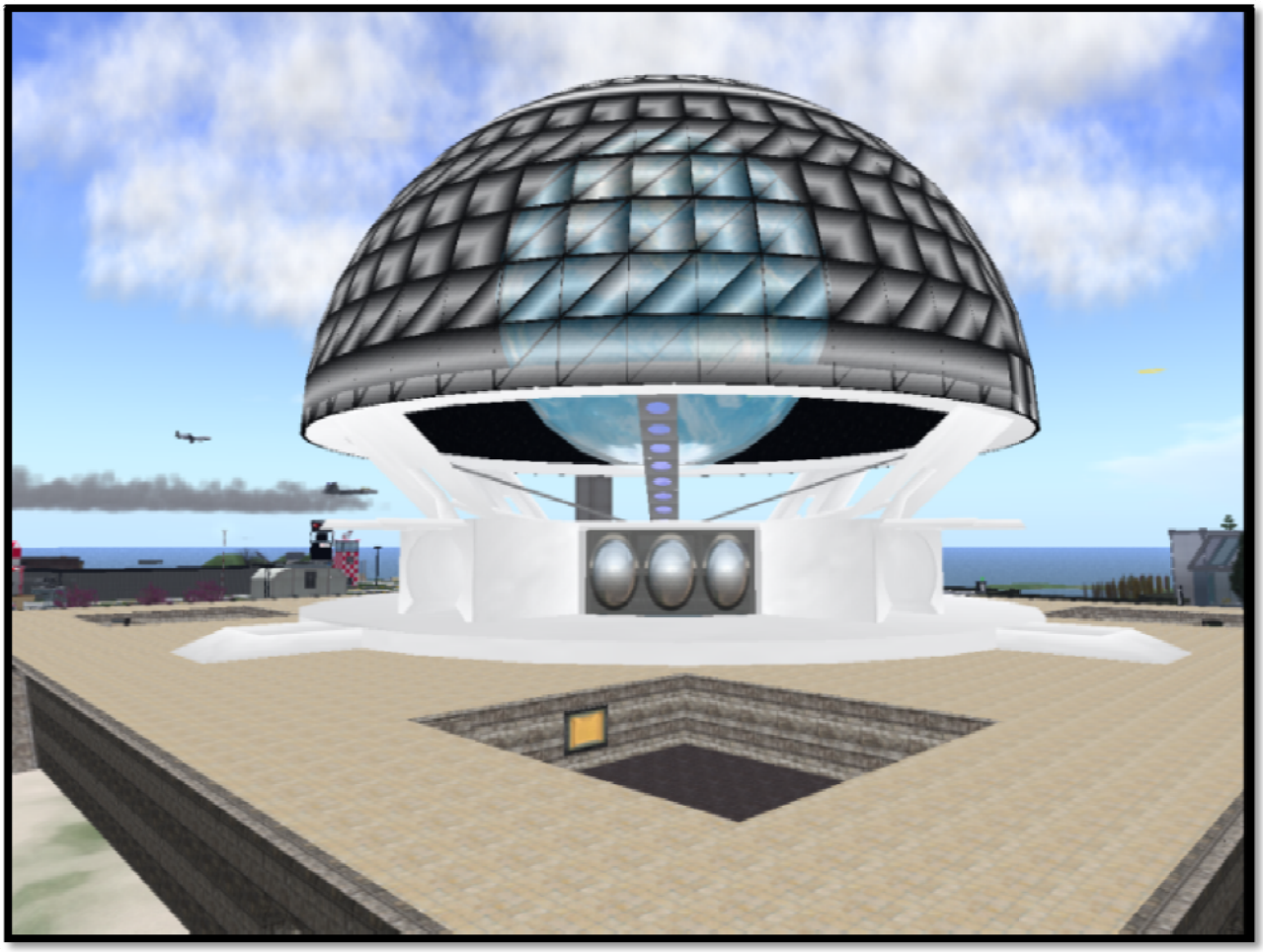


Learning Environment Prototype: Laboratory

The Laboratory prototype depicts a learning studio modeled after the Quickborner Team German design group. Workspace is clustered and furniture is open-plan to support a high-load learning environment with emphasis on efficiency. The ground floor is focused on a central rectangular atrium in the Italian tradition to convey volume and continuous interior space. The overall effect is order, concentration on the essentials, and intelligent purpose.

Learning Environment Prototype: Hologram arena

The Hologram arena prototype provides the means for learners to select from multiple learning environment options and have them appear (or rez) for immediate use. The base of the hologram rezzing area, and sandbox arenas for constructing 3D objects, is designed in the Sumerian tradition using a well-proportioned building with a long central inner space, side chambers (housing a digital library and learning resources), decorated with elaborate stone facades. Ziggurat-like steps on each side provide access to the upper terrace. In much the same way that Sumerian architectural design broke free from conventions in the pre-Sumerian settlements of southern Mesopotamia, the Hologram arena prototype suggests a break from conventions with ingenious prospects for new ways of thinking about learning environment design for harnessing capabilities offered by immersive virtual reality.



Learning Environment Prototype: Machinima studio

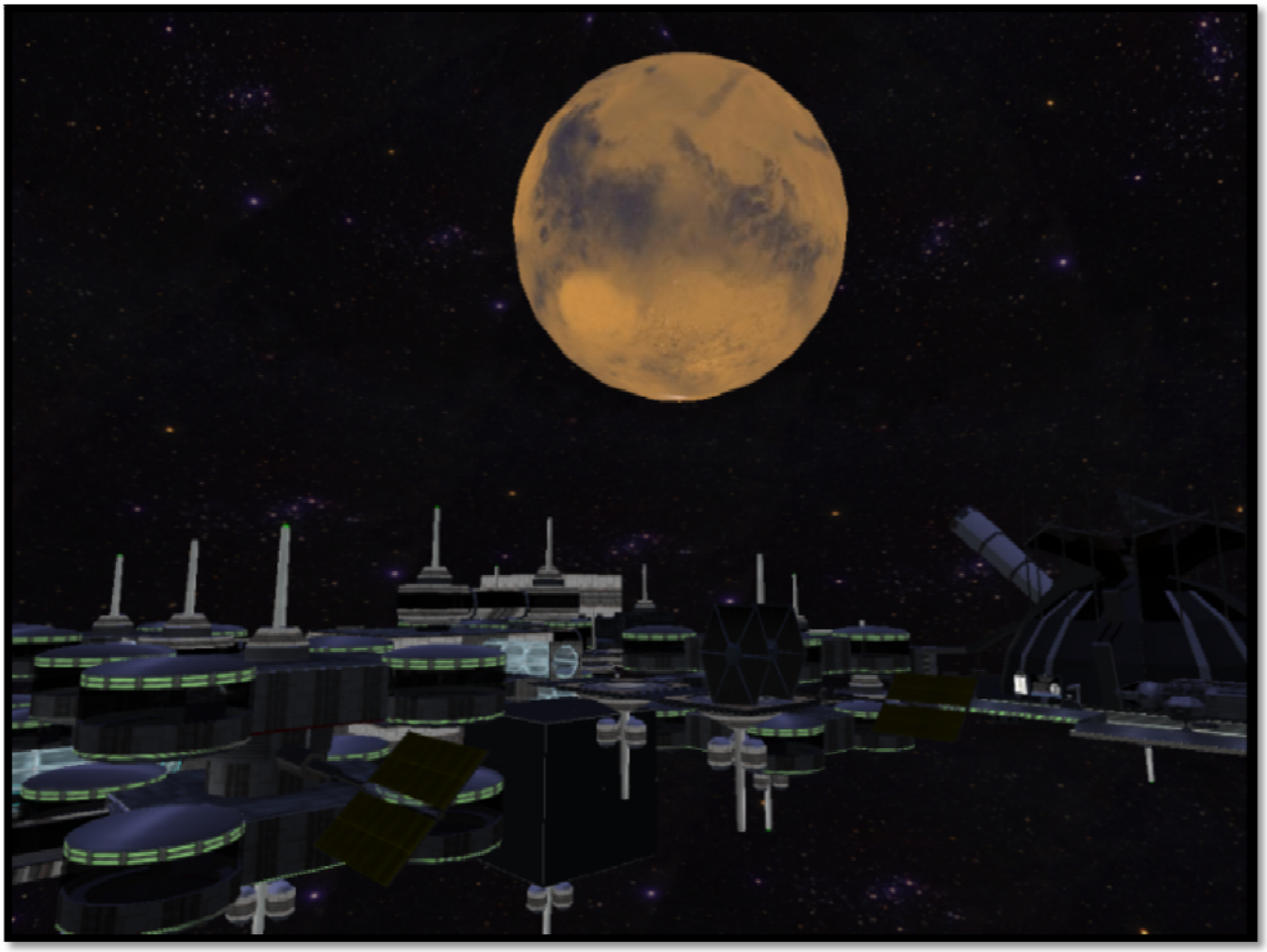
The Machinima studio prototype provides an environment for creating, editing, and showing animations using virtual equipment. The word machinima comes from combining machine and cinema together to convey the work of using virtual reality to create innovative animations and simulations, many of which are supported with avatars interacting in the scripts. The Huffman Prairie machinima setting is reminiscent of Howard Hughes production studios and conveys an air of innovative spirit involving direct engagement in shaping the way of the future via active learning.

Learning Environment Prototype: Interactive museum

The Interactive museum prototype offers opportunity to experience object-centered learning (digital rendering of physical objects surrounded with rich sets of contextual information that can inform, suggest analogies from other experiences, and stimulate thinking on related topics). Richer educational experiences are possible with multisensory input (visual, auditory, avatar movement and interaction with the object) to help foster a sense of place within a synthetic historical context. Various exhibits are also located throughout MyBase. For instance, learners can experience a virtual flight of the Tuskegee Airman P-51 Mustang.

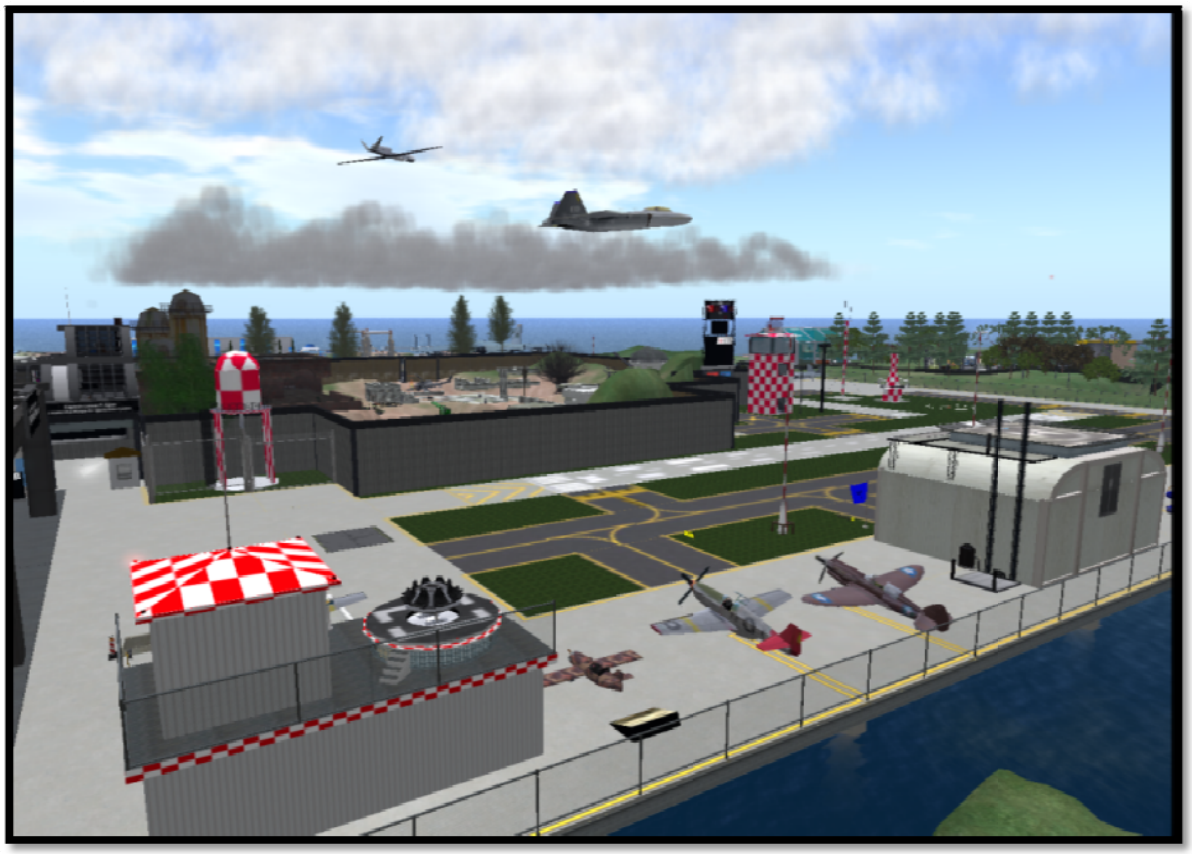
Learning Environment Prototype: Excursion trip

The Excursion trip prototype provides learners with the opportunity to virtually travel to Mars by first taking a multistage rocket to the Ayn Rand Space Station for transition to the Red Lion deep-space travel vehicle. Upon entering the orbit around Mars, learners are then taken to a surface station via a landing craft. Throughout the trip learners are interactively engaged with challenges associated with space travel and research. Excursion trips offer learners a planned linear or non-linear movement and set of activities toward an instructional goal.



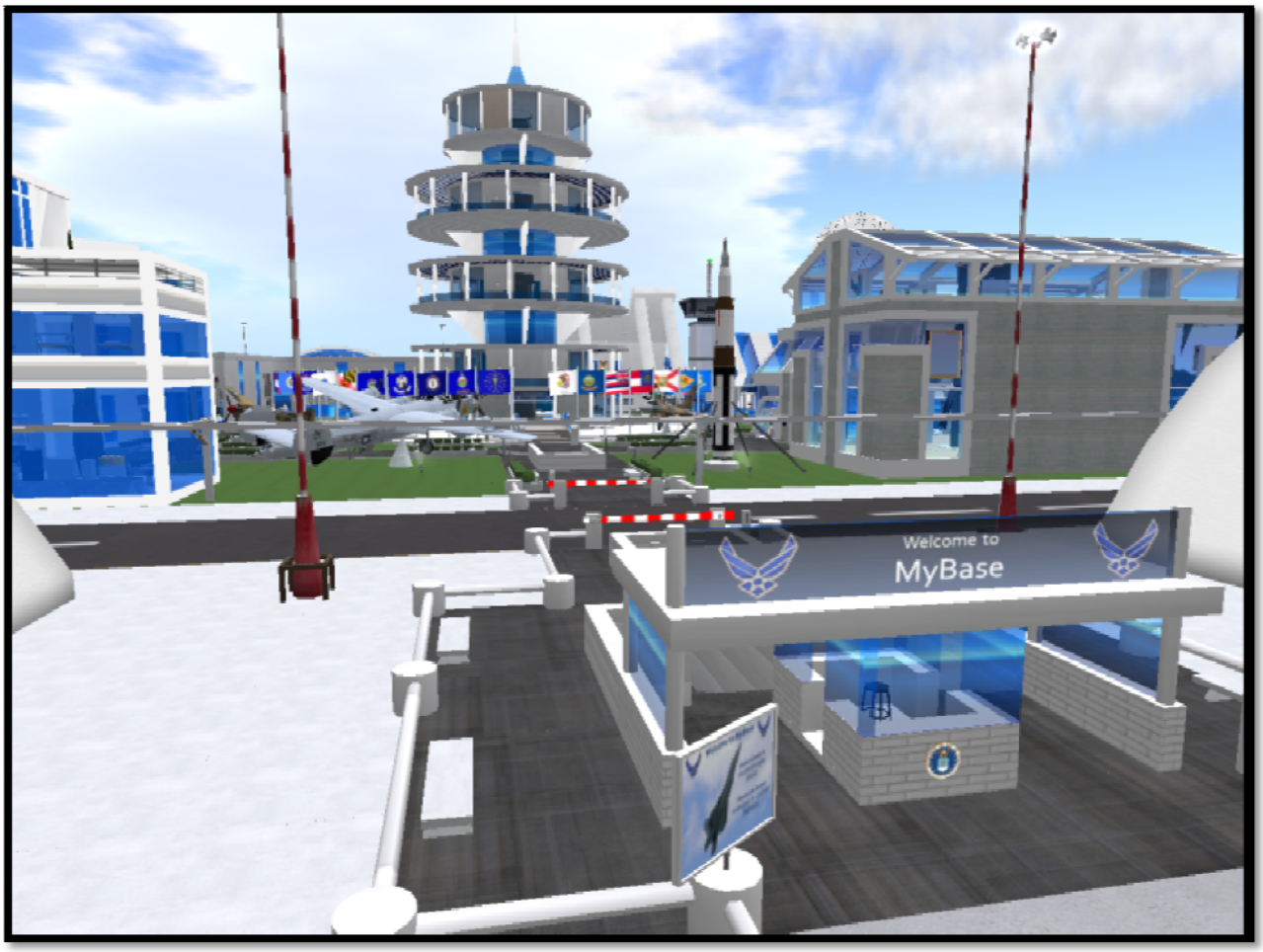
Learning Environment Prototype: Multi-player game

The Multi-player game prototype is a non-linear simulation game environment supported by a scenario-based learning framework for engaging learners with real-life challenges. A game kit for educators has been developed to support the creation of games for learning within virtual worlds (Stricker & Clemons, 2009; Hughes & Stricker, 2009). The game is played using avatars by participants (e.g., cadets, PME students, and instructors) and makes use of an immersive environment wherein game participants collaboratively problem solve in a decision-making environment to address the game's challenge surrounding the rescue of hostages held by insurgents. The game is designed to support the instruction and assessment of interdependent leadership in a simulated naturalistic environment constructed on a virtual world gaming range. The gaming range encompasses a large virtual world area wherein avatars freely move about and interact with life-like terrain, buildings, devices and equipment in the environment. The range can be readily configured to support adaptations to the game (e.g., cultural-geographic-history contexts, building structures, tools, and supporting documentation content); to include adaptations to the game on basis of participant performance. The range also is equipped with systems for supporting team membership identification, tracking, scoring, voice and text communication among team members, team briefing rooms, video recording of game activity, target damage and scoring, simulated weather, various day and night conditions, assignment of equipment and tools to each team member, and game goal-oriented task action, timing and feedback controls for use by game referees.



Learning Environment Prototype: Role immersion

The Role immersion prototype is represented via a situated virtual Air Force base (MyBase). MyBase is an exploratory and interactive environment and architecture that supports both continuous and precision learning. Visitors can enter MyBase and immerse into various Air Force roles (e.g., military recruit/trainee, etc.). MyBase can be tailored to recruit the Millennial generation, inform the public, deliver precision learning, provide pre-deployment training or even conduct operational rehearsals.



References

Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N., & Jin, M. (2008). The use of immersive virtual reality in the learning sciences: Digital transformations of teachers, students, and social context. *The Journal of the Learning Sciences*, 17, pp. 102-141.

Bransford, J., Brown, A., & Cocking, R. (2000). *How people learn*. Washington, DC: National Academy Press.

Bricken, M. (1991). *Virtual reality learning environments: Potentials and challenges*. Human Interface Technology Laboratory Technical Publication (HITL-P-91-5). Seattle, WA: Human Interface Technology Laboratory.

Hughes, R. L., & Stricker, A.G. (2009). Outside-in and inside-out approaches to transformation. In *Cross-cutting issues in international transformation: Interactions and innovations among people, organizations, processes, and technology*, Ralph Doughty and Martin Rantzer (Eds.). Department of Defense Transformation Chairs publication. Washington, DC.

Lanier, J. (Sep, 2001). Virtually there. *Scientific American*, 284, pp. 66-75.

McLellan, H. (1991). Virtual environments and situated learning. *Multimedia Review*, 2(3), pp. 25-37.

McLellan, H. (2004). Virtual realities. In David H. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology*. Mahwah, NJ: Erlbaum.

Rheingold, H. (1991). *Virtual reality*. London: Secker and Warburg.

Schroeder, R. (1996). *Possible worlds: The social dynamic of virtual reality technology*. Boulder, CO: Westview Press.

Stricker, A.G., & Clemons, L. (2009). Simulation gaming for education in MyBase: The future of Air Force education and training with virtual world learning. Proceedings, *Military Modeling and Simulation Symposium*, San Diego, CA.

Walser, R. (1992). *Construction in cyberspace*. Paper presented at the Education Foundation of the Data Processing Management Association Conference on Virtual Reality, Washington, DC.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York, NY: Cambridge University Press.

Disclaimer

The opinions and viewpoints expressed in this pamphlet are solely those of the author and do not reflect official policy or position of the US government or the Department of Defense (DoD), the United States Air Force, or Air University. Cleared for public release (AETC-2009-0513).

For additional information, contact:

Dr. Andrew G. Stricker
A4/6I Innovations and Integration Division
Air University
Maxwell-Gunter AFB, AL 36112
Email: andrew.stricker@af.edu