MOONWORLD: IMPLEMENTATION OF VIRTUAL LUNAR EXPLORATION. C. A. Wood[1], D.D. Reese[1], L. Ruberg[1], A Harrison[1], C. Lightfritz[1] and Avatrian, LLC[2], [1]Center for Educational Technologies, Wheeling Jesuit University, Wheeling, WV 26003, USA; chuckwood@cet.edu, [2]Avatrian LLC, 1200 65th St, Emeryville, CA 94608; dennis@avatrian.com.

Introduction: Tens of thousands of scientists and engineers in multiple countries are planning to send humans to explore the Moon, but none of those planners have walked on the Moon. A limited number of expensive simulations have been conducted in exotic locales on Earth to provide experience for a handful of ersatz astronauts. We are creating an alternative way for mission planners, educators and students by the thousands to gain an authentic experience of working on the Moon. We have built a virtual simulation called MoonWorld that immerses participants in a realistic geologic environment with 1/6th g and limited life support and we require them to conduct field operations.

MoonWorld is a simulation within the virtual world *Second Life* (SL). To conduct MoonWorld missions you must register with SL, create an avatar, and learn to walk and communicate in that environment. It is possible to do all of that from within the MoonWorld website (http://moonworld.cet.edu/) and SL simulation.

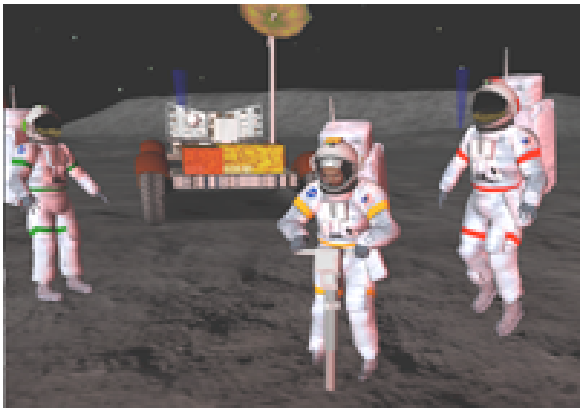
MoonWorld is modeled on the Timocharis area of Mare Imbrium. The simulation (sim) includes a crater with modeled dimensions and morphology similar to Timocharis, including terraces, slump blocks, flat floor and a central peak. We have given Timocharis conspicuous rays and a secondary crater chain to help define stratigraphic relations. A smaller crater is based on Timocharis B, a 5 km wide simple crater. This area of the real Imbrium does not include volcanic landforms. To add variety to the field investigations we have added a morphologically fresh lava flow and volcanic dome, modeled on the flows in western Imbrium and the Kies Pi dome.

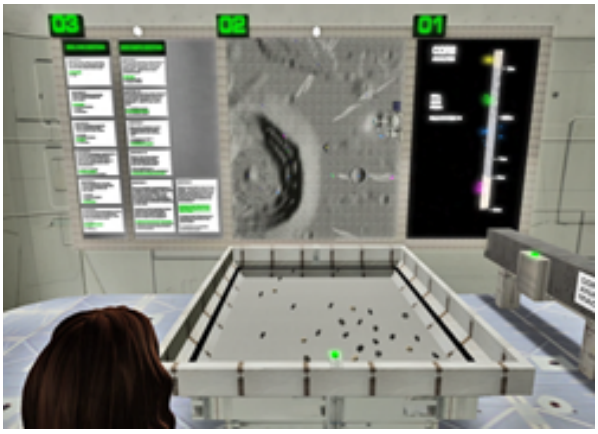
MoonWorld is not a game, although there are neat space systems to use (lunar orbiter, base, and rover) and dramatic terrains to explore. The goals of MoonWorld are for participants to learn about the formation of impact craters and volcanic features, to deduce stratigraphic relations among them, and to gain an appreciation of the processes and difficulties of living and conducting fieldwork on the Moon.

Avatars arrive at the Lunar Orbiter where they watch a machinima (SL video) overview of lunar geology and receive instructions for working in SL. They put on a jumpsuit and enter the lunar lander vehicle for the trip to the lunar surface. On arrival the avatars tour the base and get into their spacesuits for work on the surface. Exiting an airlock they learn to use their rock grappler and navigation tools and then collect contingency samples.

Astronaut avatars visit 16 field stations, making observations, collecting samples, taking measurements and answering questions. There are 3 types of samples: anorthosites, basalts and impact melt, with some being brecciated. On the rim of Timocharis they drill a 5 km deep core, collecting samples only where lithologies change – isn't virtual technology wonderful!

On return to the base the core is uploaded into an automatic analyzer and the samples are deposited on an examination table in the research facility. A series





of questions is asked that tie together rock and core samples with observed geology. At the end, avatars determine the stratigraphy of the region.

Because work on the real Moon is severely limited by the use of consumables, spacesuits in MoonWorld track and display the amount of air and water remaining in their backpacks. The consumption rate depends upon the level of exertion, with more expended when climbing crater rims than when loping across a level plain. Activity on the surface is accompanied by audible breathing, with greater exertions resulting in louder panting.

The lunar base includes a Bioregenerative Life Support System (BLiSS) based on prior NASA re-

search, to generate and recycle consumables – water, oxygen and food. Hydroponic growth chambers for lettuce, potatoes, wheat and soybeans are depicted, and in a future version of MoonWorld, avatars will be able to select different proportions of these crops to maximize support for lunar crews. Also in the future we will introduce emergencies – solar flares or fungi that attack crops - that require avatars to improvise and collaborate to solve crises.

Educational Aspects: MoonWorld is designed to be an educational simulation. Its content is consistent with the Scientific Inquiry and Universe benchmarks of the *Atlas of Science Learning* published by AAAS. Currently MoonWorld is only accessible to people 18 years and older because that is a limitation of SL. We are exploring options to duplicate MoonWorld in the SL Teen Grid (but few adults are allowed there) or to install it as a stand-alone instantiation of SL on our servers.

Mission Planning Aspects: MoonWorld also may be of value to scientists and engineers planning for a return of humans to the Moon. The realistic 1/6th g environment, hardware usage, airlocks and BLiSS systems allow trial runs of mission planning. For different needs than currently represented in MoonWorld our development team is available to custom design topography and equipment. We welcome comments and inquiries.

Access: MoonWorld is available through our website at: http://moonworld.cet.edu/. A machinima YouTube video overview of MoonWorld is viewable at http://www.youtube.com/watch?v=TXpTKp35clg If you didn't get to go to the Moon during Apollo – now is your chance!