



MoonWorld - Exploring the Moon in Virtual Worlds

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Abstract

Only 12 people have ever walked on the Moon, but with virtual worlds technology anyone can. MoonWorld is a NASA-sponsored development of virtual geologic fieldwork on a simulation of the lunar surface. MoonWorld was created for learners to gain a visceral understanding of lunar geology – impact cratering and volcanism – by conducting field observations in a realistic, spacesuit environment. MoonWorld is a research project to measure the effectiveness of science learning in virtual worlds such as Second Life.

1. Introduction

MoonWorld is an immersive learning experience currently developed for the virtual world Second Life. MoonWorld immerses participants in a realistic lunar geologic environment with $1/6^{\text{th}}$ g and limited life support, and we require them to conduct field operations. 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.

2. Life Support

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 MoonWorld lunar base includes a Bioregenerative Life Support System (BLiSS) based on prior NASA research to generate and recycle consumables – water, oxygen and food. Hydroponic growth chambers are depicted for raising lettuce, potatoes, wheat and soybeans; 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.

3. 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 Second Life. We are duplicating MoonWorld in OpenSim, an open source version of Second Life, as a stand-alone instantiation to run on our servers, allowing anyone to experience the simulation.

4. Related Lunar Learning

Visitors to MoonWorld are also directed to related lunar education opportunities developed by our team. These include *Selene* (selene.cet.edu/), a videogame to promote and assess learning of lunar science concepts, using processes such as accretion, differentiation, impact cratering and volcanism. As players build and modify a moon, *Selene* measures learning as it occurs. People who wish to learn more about the Moon can also visit our websites *Lunar Photo of the Day* (lpod.wikispaces.com/) and *The Moon Wiki* (the-moon.wikispaces.com/).

5. Access

MoonWorld is available through our website at: moonworld.cet.edu/. A machinima YouTube video introduction to MoonWorld is available at www.youtube.com/watch?v=TXpTKp35cIg If you didn't get to go to the Moon during Apollo – now is your chance!

6. Summary and Conclusions

Virtual worlds offer the next innovation in online education. Learners can actually carry out educational activities through realistic immersion in environments that are not accessible in reality. MoonWorld offers anyone a chance to experience the Moon as astronauts once did. Additional environments will be constructed including other planetary surfaces and perhaps a small asteroid with very low gravity. What is being explored today as an education tool may become a high fidelity training simulator to prepare future generations of astronauts for missions to new worlds.

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