SECOND LIFE: A VENUE FOR INFORMAL EDUCATION AND PARTICIPATORY EXPLORATION.
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Introduction: Second Life (SL) is an online 3D Multi-User Virtual Environment in which avatars (a virtual representation of one's self) interact via communicating, learning, exploring, playing, and conducting business together (http://www.secondlife.com). SL is completely user-generated and self-evolving, such that each time a resident logs in they may find that their surroundings have changed or that new places, objects, and people exist where before there were none. As of January, 2008, SL had 11,740,064 "residents" from over 100 countries. In addition to individuals, SL residents include many real life (RL) groups, including federal agencies (e.g. NASA and NOAA), universities, museums, planetariums, libraries, businesses, nonprofits, embassies, and the tourism departments of many countries.

Most SL residents fall within the 25-34 year old demographic (36.9%), with 18-24 year olds comprising the second largest group (25.1%). This is significant in light of recent research that found that for young people between 18-25 years of age, 68% describe themselves as "Neutral" or "Not excited or interested" in human missions to the Moon and 80% are "Neutral" or "Not excited or interested" in human missions to Mars [1]. The oldest individuals mentioned by [1] are at least 26-28 years old as of the writing of this abstract, which places them within the 25-34 year old demographic representing the majority of SL residents. Considering NASA's current plans to send humans to both bodies as outlined in its Vision for Space Exploration (VSE), the findings of [1] are disturbing. As [1] points out, this age group will be an important part of the workforce during the years in which the VSE is implemented. Thus SL provides an ideal opportunity and venue for NASA to reach out to and include this demographic in its education, especially informal education, and exploration efforts.

Informal education within Second Life: Both formal and informal education occurs within SL. Formal education includes classes, training, and simulations. Informal education includes immersive museum exhibits, planetarium shows, library programs and services, public lectures, re-enactments, role-playing, concerts and performances.

Museums. Some RL museums maintain a SL museum. An example is The Exploratorium in San Francisco, CA, whose 'Splo (SploLand 128, 128, 0) contains over 100 interactive exhibits. However, one of the most popular museums within SL based on visitor statistics is the International Spaceflight Museum (Spaceport Alpha 27, 109, 22), which does not have an affiliation with a RL museum but was created by a group of residents with the common interest of spaceflight. Among its numerous exhibits are a rocket garden built to scale and a planetarium. Such amateur-created museums are more the norm in SL than those created by a RL counterpart. This suggests that residents of SL are very interested in museum visits as a form of "serious leisure", such that they are open to informal learning experiences within SL [2].

Exhibits. SL is well-suited for informal education through immersive exhibits because they are not limited by buildings, horizontal space, gravity, or even the Earth. Research pertaining to the advantages and disadvantages of using SL for exhibits shows that visitors find those exhibits in which they become interactively immersed as more memorable than those in which they do not [3]. Visitors can interact with exhibits in SL in ways they cannot in RL, such as easily changing their visual and positional frame of reference in relation to an exhibit, moving through 3D views, easily changing the scale of objects within an exhibit, accessing hyperlinked supplemental information pertaining to an exhibit, experiencing "dangerous" situations and remote locations that they would not be able to otherwise, contributing to an exhibit by creating dynamic content, and interacting with, learning from, and collaborating socially with other people from throughout the world [3]. Many SL exhibit designers have taken this flexibility into account when building exhibits. At the International Spaceflight Museum for example, visitors may choose to take a rocket ride into low Earth orbit in order to view exhibits about the Solar System.

As noted above, SL is conducive to large or complex exhibits whose intent is to demonstrate a sense of scale. Research by [4] has shown that often neither students nor the general public fully understand and appreciate the scale of the Solar System and Universe. The Exploratorium's 'Splo has created an exhibit called "The Orbital Experience" that addresses this issue. Avatars teleport to a platform in the sky above the museum where they sit on planets as they orbit a pole representing the Sun. By choosing different bodies visitors get a sense of the scale of the Solar System.

Exhibits such as these in RL would require tremendous space and money to build and maintain in addition to a large amount of time and energy on the part of the visitor to travel to and see them in their en-

tirety. In SL, however, large exhibits are easily built and maintained and are easily accessible and traversed by visitors since their avatars may fly or teleport to the exhibit or its different components without tiring. Due to the ease with which SL can be accessed and with which avatars can travel, the medium is also ideal for engaging the disabled in experiences that may otherwise be inaccessible in RL.

Social interaction. An important aspect of many educational venues within SL is that they offer opportunities for social interaction. The opportunity to interact with others with similar interests (individuals who in RL may be located around the world) in real time is a powerful incentive for encouraging museum visits [2]. Sometimes, social events at educational locations within SL have little to do with the actual subject of the location. For example, the International Spaceflight Museum offers a weekly opportunity for visitors called "Jazz in Outer Space" during which participants gather to listen to streaming music, dance, and socialize. Even though the event has little if nothing to do with spaceflight, it offers a chance for participants to meet each other and potentially engage in meaningful conversations related to spaceflight and the museum. Such events could draw visitors that may never have chosen to visit the museum otherwise, potentially enlightening them to new information they may find of interest.

NASA's current efforts in Second Life: NASA has established a presence in SL through CoLab (NASA CoLab 244, 110, 22) and JPL's Explorer Island (Explorer Island 182, 169, 22). CoLab originally began as an initiative of Ames but its weekly meetings within SL have evolved to include representatives from NASA HQ, each Center, JPL, and SL residents interested in space exploration but who do not have an official affiliation with NASA. Among its many goals, CoLab aims to increase public knowledge of and involvement in space science and space exploration, to create a more intimate and tangible experience of NASA with the public, and to complement the RL CoLab with an online space (http://colab.arc.nasa.gov/ and http://nasacolab.org). CoLab in SL currently includes a few exhibits on NASA missions, a scale model of Victoria Crater, access to the NASA Web portal and streaming NASA TV, meeting spaces and an area in which visitors may practice building objects. Under development is a virtual Educator Resource Center. In addition to providing a space to socialize, it will provide access to lesson plans, classroom resources, and information on events and opportunities in both SL and RL. JPL's Explorer Island includes access to streaming NASA TV, space for meetings and live events such as lectures and launches, and exhibits on past and current missions in which JPL is involved. Interactive exhibits include opportunities to view an airbag demonstration or ride a model of one of the Mars Exploration Rovers.

Participatory exploration with NASA in Second Life: Although NASA has a presence in SL, many opportunities exist within the medium that have yet to be fully realized and explored. Aside from Ames and JPL, NASA's Centers are poorly represented in SL. Opportunities abound for each Center to provide exhibits, resources, and experiences related to the individual missions in which they participate or lead. SL also provides a venue in which the public could easily engage in participatory exploration with NASA, such as viewing or analyzing real time or archived mission images and data while exploring a virtual Moon or Mars, thus contributing to the exploration effort being paid for by their tax dollars. The ability to incorporate real time data into SL has already been demonstrated by NOAA with its Real Time Weather Map (Meteora 177, 161, 27). Such an effort by NASA was suggested at the Participatory Exploration Summit held in June, 2007, the purpose of which was to discuss the use of SL and other types of "new media" to engage the public in meaningful collaboration and exploration with NASA [5]. The potential outcomes and benefits to NASA of participatory exploration as identified by the Summit attendees include gaining advocacy, encouraging innovation, building relevancy and a constituency through marketing, and developing partnerships [5].

Conclusions: SL is a powerful medium in which its residents shape its content. It provides opportunities for distance, social, collaborative, and self-paced learning, in both formal and informal contexts, with around the clock access to learning tools and resources. SL is an effective means by which to communicate with, engage, and educate the general public world-wide. Museums and exhibits within SL are especially conducive venues for informal education due to their ability to provide a gathering and meeting place for residents with common interests to socialize, collaborate, and learn together. SL provides NASA with an opportunity to engage the public, particularly the 18-35 year old demographic, in its education and exploration efforts.

References: [1] Dittmar M. (2006) in *Proceedings of AIAA Space 2006*. [2] Urban R. et al. (2007) in *Museums and the Web 2007: Proceedings*. [3] Seligson J. (2007) *Museum News*, Sept./Oct., 55-60. [4] Harvard-Smithsonian Center for Astrophysics (2005) *Beyond the Solar System: Expanding the Universe in the Classroom*. [5] Santiago D. (2007) NASA/CP-2007-214566.