LUNAR CAVES ANALOG TEST SITES FOR SPACE-STEM ENGAGEMENT. S. W. Ximenes[1], D.M. Hooper[1], A. Palat[1], L. Cantwell[1], M. Appleford[2], J. Webb[2], R. Wells[2], E.L. Patrick[3], M. Necsoiu[3], [1]WEX Foundation, 110 E. Houston Street, 7th Floor, San Antonio, TX 78205, [2]The University of Texas at San Antonio, 1 UTSA Circle, San Antonio, TX 78249 [3]Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78238.

Introduction: Inspiring the next generation of space explorers is a major objective for the scientists, engineers, and educators of today. To improve Space-STEM teaching and student comprehension, we have created the Lunar Caves Analog Test Sites (LCATS) program for science investigations, space exploration mission operations, technology development, and habitability system architectures. The LCATS program environment incorporates a pipeline of motivated middle and high school students to assist professionals in solving real-world challenges in space-exploration technology. Critical thinking, problem solving skills, teamwork, and mentoring enhance the student experience. Learning performance benefits from the use of robotic technologies, terrestrial analogs for testing technology projects and operational processes in a mission context. Local Texas caves in the area and region are utilized as analog environments for fielding student experiments and technology challenges through simulated missions.

Figure 2. LCATS Student Field Trips to Local Caves

Investigations of In Situ Resource Utilization (ISRU) technologies, e.g., regolith simulant research and 3D printed manufacturing for habitat design and planetary construction are incorporated into project curriculum.

Student teams (cohorts) from the San Antonio area school districts are guided by subject matter experts in their development of innovative hands-on applications that provide practical solutions for lunar mission exploration and architecture challenges. LCATS goals include preparing and encouraging underrepresented minorities, female and economically disadvantaged students to pursue higher education and careers in human space exploration.

Framework: LCATS works within the framework of a larger lunar site development program known as LEAP2 (Lunar Ecosystem and Architectural Prototype). LEAP2 is a commercial lunar site development program being developed by an international consortium of aerospace industry organizations investigating technologies for lunar settlement. The LEAP2 international consortium is loosely organized for collaboration with industry, academia, and government organizations. LEAP2 addresses space architecture research in lunar exploration, economic development, mining, and sustainability at a specific lunar site identified as the Marius Hills Skylight. The skylight is located within an area of volcanic domes in the Marius Hills region of Oceanus Procellarum at 14.2°N, 303.3°E [1]. It is a large pit subsurface feature believed to be the opening to a lunar lava tube cave useful for eventual human habitation.

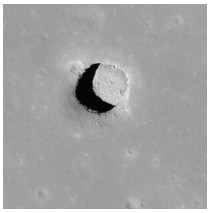

Fig 1. MH Pit
NASA/GSFC/ASU

The LEAP2 consortium uses the Marius Hills Pit as a case study for determining required technology development needed to access these type of geologic features for exploration and eventual human settlement. Projects within the LEAP2 program address various technology solutions and missions for achieving multi-generational program goals to develop the lunar site for eventual human settlement.

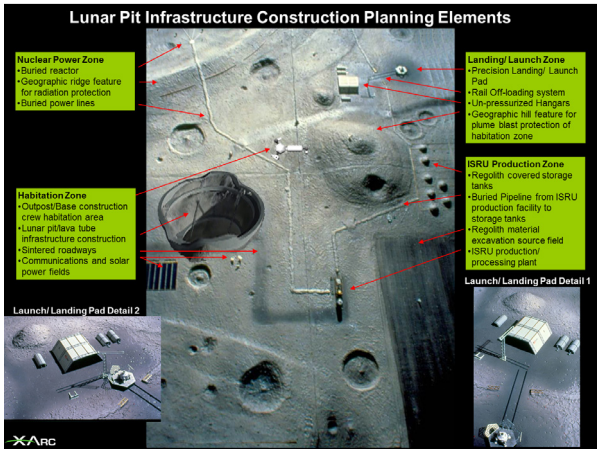

Figure 3. LEAP2 Lunar Infrastructure

Project-based Learning: LCATS is a NASA funded program administered by the non-profit WEX Founda-

tion [2]. LCATS provides real-world context for students to assist aerospace professionals with solving actual space exploration technology development challenges using project-based curricula. The benefit of project-based educational programs is quite established [3][4]. Project-based learning, a teaching methodology that utilizes student-centered projects to facilitate student learning, is touted as superior to traditional teaching methods in improving problem solving and thinking skills, and engaging students in their learning [5][6].

Figure 4. Lunar Surface/Subsurface Robotics Testbed

Student projects and curricula of the LCATS program are attached to actual technology, engineering and science investigation challenges associated with the growth phases of human settlement at the Marius Hills Skylight. The LEAP2 commercial lunar site development program provides a framework for LCATS project-based curricula development to be aligned with the goals of the commercial venture for actual development of the lunar site [7].

Figure 5. Robotics Field Test in Cave Environment

The differentiator with the LCATS/LEAP2 education initiative is the specificity of its technology research and development projects. For project-based learning, all consortium sponsored curricula initiatives are focused on their application to advancing the body of knowledge for site development of planetary pits and lava tubes, in particular, development of the Marius Hills Skylight as a commercial prototype for understanding how to use these planetary features to the benefit of human settlement on distant planets.

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