BRINGING THE LUNAR SHADOWED REGIONS TO LIGHT WITH REAL TIME RENDERING IN UNREAL ENGINE. K. M. Cannon[1] [1]University of Central Florida, Orlando FL. Email: cannon@ucf.edu.

Introduction: High-resolution imaging from the Lunar Reconnaissance Orbiter WAC and NAC cameras is typically available for all equatorial sites of interest on the Moon. However, near the poles, the Seasonally Shadowed Regions (SSRs; [1,2]) and Permanently Shadowed Regions (PSRs;) have very low signal, necessitating stretched imagery which is often of poor visual quality (Fig. 1). This makes it difficult to visualize the terrain inside the SSRs and PSRs, especially for future mission planning activities. Here, I demonstrate how real-time rendering engines can be used to bring these regions to light and can aid in lunar exploration.

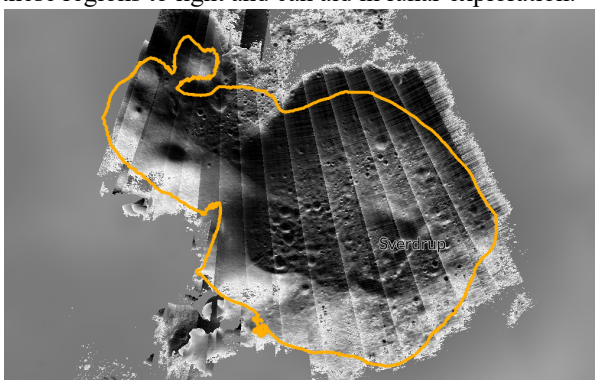

Fig. 1. NAC mosaic of Sverdrup crater PSR.

UE4: Unreal Engine 4 (UE4) is a real time game engine developed by Epic Games, most famously used in the popular Fortnite platform. Going beyond gaming, the underlying UE4 engine has also been used for increasingly diverse applications in architecture, film, engineering, automotives, and virtual reality simulations/training. A small handful of use cases involving planetary science data have been described [3,4].

Real time rendering is ideal for polar terrains because the lighting conditions can be accurately rendered and updated in real time based on computed orbital parameters and known scattering properties of lunar regolith. Instead of using color imagery from WAC/NAC, texture maps with multiple Levels of Detail (LOD) can be used to create photorealistic landscapes.

Process: As a demonstration, I created a scene in UE4 to simulate the terrain at Sverdrup crater (Fig. 2), an attractive site for potentially rich ice deposits [5,6]. Topography was generated in polar stereographic projection at 5 m/px resolution from individual LOLA RDR tracks. Outlier points were removed, then multiple nearest neighbor interpolations with a subset of the points removed were averaged together. Lighting was created using a directional light source to represent the sun, with azimuth and zenith angles calculated using the NAIF SPICE toolkit. An optional, weak omnidirectional light was also added such that the terrain inside the shadowed regions is visible, with the true shadowed boundary still clearly demarcated.

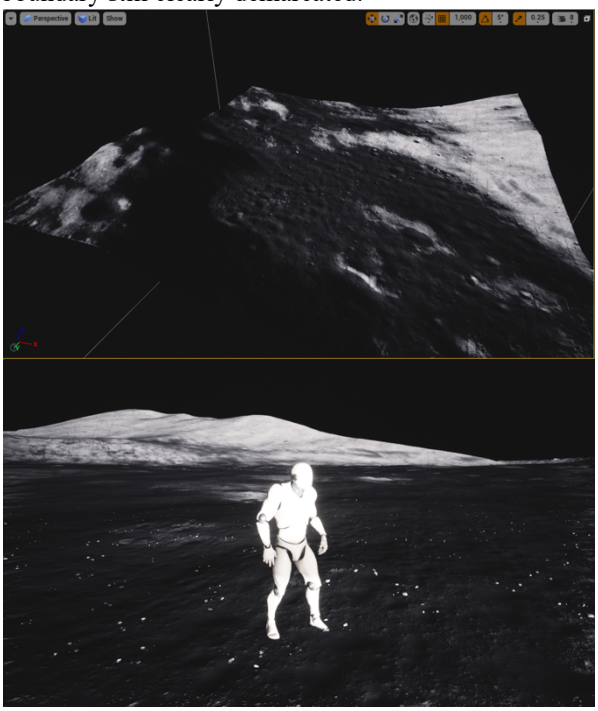

Fig. 2. UE4 demonstration of Sverdrup crater.

Applications: Real time rendering engines using the techniques described here can be used for a wide array of future studies and exploration activities. Example use cases include: (1) Landing site selection/analysis for space agencies and commercial companies; (2) Traverse planning and mission operations planning that take dynamic lighting conditions near the poles into account; (3) Virtual reality simulations of vehicle operations and human extra-vehicular activities; (4) Physics-based simulations of rocket plume effects and the geometry of mitigating topography/berms; (5) Mockups and layouts for habitats, ISRU processing facilities, and villages/hotels. A key advantage of UE4 is that any 3D assets rendered in CAD (or otherwise) and architectural BIMs can be directly imported and dropped into the scene.

References: [1] Kloos J.L. et al. (2019) *JGR 124*, 1935. [2] Williams J.-P. et al. (2019) *JGR 124*, 2505. [3] Wu B. et al. (2019) IEEE/RSJ IROS Conf., pp. 3262-3267. [4] Elgner S. et al. (2017) *EPSC* EPSC2017-481. [5] Cannon K.M and D.T. Britt (2020) *Icarus*, *in press*. [6] Li S. et al. (2018) *PNAS 115*, 8907.