

**AS A HUMAN STANDING ON THE SURFACE OF TITAN.** W. J. O'Hara <sup>1</sup>University of North Dakota & Explore Titan, Inc., [executivedirector@exploretitan.org](mailto:executivedirector@exploretitan.org).

**Introduction:** Via the moon-to-mars program, NASA has established a blueprint for expanding human presence throughout the solar system. [5] Titan is a logical option as the next destination after Mars and subject to application of this approach to human exploration. However, Titan is a very different place than the Moon or Mars. The surface is wet with liquid ethane and methane. Sunlight reaching it is a hundredth of what we receive at the Earth and Moon. We must ask ourselves, what would it physically be like for a human to stand on its surface? The work described here integrates our knowledge of Titan, supplements it with available simulation tools such as Celestia ([celestiaproject.space](http://celestiaproject.space)) and Space Engine ([spaceengine.org](http://spaceengine.org)), to consider environmental factors that would affect the human, such as surface temperature, air density, ground texture, winds, gravity, and lighting. The result is the first comprehensive description of what it would be like for a human to stand on the surface of Titan. This information provides insights into extravehicular activity (EVA) suit design, surface habitat design and mission hazards identification.

**Background:** The Cassini-Huygens mission collected data critical to improving our understanding of Titan. On landing, Huygens collected data on the consistency of the surface layer. Before and after it landed it collected wind and temperature data. Pictures returned by the probe showed a cobblestone-littered terrain, lit by diffuse, orange-tinted sunlight. These results are captured well in works by numerous researchers such as Mitchell & Lora [4], Coustenis & Hirtzig, [1] and others. Additionally, Lorenz [3] summarized conditions such as lighting, weather and gravity at surface.

Outside of science fiction novels, the concept of humans traveling to Titan has been explored primarily only in passing and mostly in news articles by [space.com](http://space.com) [7], [astronomy.com](http://astronomy.com) [6] and others. Lorenz [3] touches on the subject as well. Wohlforth & Hendrix [8] described the potential for colonization of Titan, however, much more can be explored regarding the approach and experience of the initial phases of human exploration. The newly formed non-profit, professional organization, Explore Titan, Inc, seeks to expand on the topic through collaborative discussion between the scientific and human spaceflight communities as well as through educational outreach.

**Approach:** This study is performed via data collection and integration and software simulation. The

goal is to build a virtual impression of the surface of Titan as would be experienced by a human on the surface including the senses of sight, smell, touch and hearing. As no work to date has focused on human exploration of Titan at this scale, it is necessary to draw upon relevant data from numerous sources. By integrating this data together we begin to construct a mental model of what it feel and look like for a human to explore the surface of Titan.

It was determined that additional information was needed to fully answer the questions of what human senses would perceive on Titan. Specifically, over the course of the Titan day and year a human at various locations on Titan would experience different lighting conditions. We sought to fill gaps in our understanding of these lighting conditions through use of available solar system modeling tools. These tools are used to model the motion of Titan as it orbits Saturn and as the entire system orbits the sun. Since the Saturnian system is tilted at 25° to the ecliptic, humans on the surface would experience seasonal changes in lighting which vary based on latitude and longitude. Additionally, given Titan's tidally locked configuration, analogous to Earth's Moon, one side of Titan would benefit from reflected light from Saturn while the other side would not. All these factors would affect how much ambient light a human would experience during the diurnal cycle. These data are integrated with reported data concerning seasonal weather patterns to estimate what the human might experience at different times of the year and at different locations.

**Benefits and Next Steps:** This study is the first attempt at aggregating what we know about Titan to factually estimate the experience of a human on its surface. The results will inform future work including surface EVA space suit design (See [2] for an initial concept), habitat design, virtual reality simulations and terrestrial analog exploration. Next steps will be to extract from this work environmental requirements and potential hazards that will need to be addressed. We will use this information to generate discussion about what it would mean for human exploration of Titan and develop concepts for EVA suits and habitats.

**Summary:** By aggregating data, supplemented by solar system software simulation, this study estimates the experience of a human exploring Titan, a likely future destination after Mars. This work benefits follow on efforts to further mature concepts for human missions deeper into our solar system following NASA's blueprints.

**References:** [1] Coustenis, A., & Hirtzig, M. (2009). Cassini–Huygens results on Titan’s surface. *Research in Astronomy and Astrophysics*, 9(3), 249–268. <https://doi.org/10.1088/1674-4527/9/3/001>. [2] Dijoux, J., & Lee, P. (2024). A Spacesuit for Titan. *NSS ISDC 2024*, 1001. [3] Lorenz, R. D. (2020). *Saturn’s Moon Titan: From 4.5 billion years ago to the present*. Haynes Publishing. [4] Mitchell, J. L., & Lora, J. M. (2016). The Climate of Titan. *Annual Review of Earth and Planetary Sciences*, 44(1), 353–380. <https://doi.org/10.1146/annurev-earth-060115-012428>. [5] NASA. (2023). *NASA’s Moon-to-Mars Strategy and Objectives Development* (P-2023-03-3115-HQ). NASA. [https://www.nasa.gov/wp-content/uploads/2023/04/m2m\\_strategy\\_and\\_objectives\\_development.pdf?emrc=c21aff](https://www.nasa.gov/wp-content/uploads/2023/04/m2m_strategy_and_objectives_development.pdf?emrc=c21aff). [6] Oakes, nick. (2023, November 1). *Why Titan should be on humanity’s must-visit list* / *Astronomy.com*. <https://www.astronomy.com/science/why-titan-should-be-on-humanitys-must-visit-list/>. [7] Tate, K. (2015). *How Humans Could Live on Saturn’s Moon Titan (Infographic) | Space*. <https://www.space.com/28788-living-on-titan-saturn-explained-infographic.html>. [8] Wohlforth, C., & Hendrix, A. (2016). *Beyond Earth: Our Path to a New Home in the Planets* (First Edition). Pantheon.