

Shashank Madhu  
November 10, 2013  
Grade 10

### A New Home in the Final Frontier

On July 20, 1969, at approximately 8:17 PM, the entire world watched with a bated breath as two men stepped out of an otherworldly craft and onto an alien and inhospitable world. As the world looked on, one of the men uttered a single line, "That's one small step for [a] man; one giant leap for mankind." For such a simple phrase, the implications of its meaning were astronomical; the culmination of almost a decade of work, several more decades of research and many centuries of dreaming and aspiring was mankind's first step on the path to the exploration of the universe by journeying to its nearest neighbor and satellite; the Moon. Mankind has since slowly retreated from the exploration of the Moon, due to domestic constraints. However, if the human race is to ameliorate and prosper, then the key step in this goal is for humanity to rise to the challenge of exploring, settling and utilizing the universe around them, starting with the moon, for the betterment of society. The colonization of the moon is a quintessential step in mankind's discovery, exploration and eventual settlement of the universe around Earth. Through this, the human race will be able to reach beyond its current limitations and boundaries and instead utilize the cosmos for the goals and purposes associated with conquering the Final Frontier.

The idea of exploring and eventually colonizing the moon is not a novel one; in fact, the first accounts of such an adventure came from over two millennia ago. In this account, written by the Greek author Lucian, a group of explorers are magically transported to the Moon, where they find themselves in the middle of a war between the Sun and the Moon over the rights to the planet Venus (Wendell 865). More accounts of such an expedition can be found in early modern writing, such as in a book by the Bishop John Wilkins, in which he "...voiced the opinions that man would one day learn to fly and would plant a colony on the moon". However, all these sources were just hypothetical, even ludicrous, ideas for their time, and so it was not until the advent of the modern space rocket that anyone considered the idea of exploring and settling the moon. The first logical account of planting a colony on the moon was made by the US Army, where they planned to establish a twelve man base on the moon by the year 1967. These beliefs became more vehemently proposed as manned missions to the natural satellite increased in number and magnitude, and many people believed that it was only a matter of five years or so before a bases would be established on the moon. However, with the discontinuation of the Apollo program talks of settling the Moon became increasing limited in voice and support until only a few enthusiasts remained on the topic. It seemed as though people had lost interest in space due to other impediments such as economic straits, etc. The discovery of water on the moon helped to rekindle some efforts to return and settle the moon, but the support for this is still very faint. Unperturbed, some private agencies have spearheaded plans for their own commercial rockets and manned programs to send people back to the Moon. For instance, the International Lunar Exploration Working Group (ILEWG) has proposed plans for a "Lunar Ark" which will hold the secrets of mankind in the case of a civilization ending event. Still, even plans to return to the moon are few and far between, and it is unlikely for any space agencies to return to the rocky body before this decade is over.

In the miraculous chance that the people of this world come to the conclusion that it is imperative and beneficial to the human race to explore the Moon, several factors will have to be taken into account. For instance, one major predicament that hampers moon colonization is the sheer amount of materials, and the cost of those materials, that would need to be transported to the Moon along with humans to establish a successful outpost on such an inhospitable world. Today, the cost of shipping

one pound of cargo into space and to the moon is approximately \$50,000. If a space agency was to transport several humans, along with shelter, food and the equipment required to generate power on the moon, the total cost of such an enterprise would be exorbitant. Therefore, either the transportation price per poundage of cargo must come down, or all the materials necessary to survival on the moon must come from the moon itself. This method of utilizing resources discovered on an extraterrestrial body for the enhancement of a colony or expeditionary team is known as in-situ resource utilization, or ISRU. ISRU has a major potential to be an asset to future explorers and colonists as it reduces the amount of cargo that would need to be transported from the mother planet; instead, only the equipment that would need to be used to produce the goods required for survival on a new planet would be transported. This would in turn save an abundance of money, fuel and transit time between the Earth and the Moon.

To establish a colony on another planet or heavenly body, colonists require food, water, shelter, air, communication with the home planet and power. Communication is the easiest challenge to tackle; radio waves and other waves of the electromagnetic spectrum travel just as well, if not better, in the vacuum of space as on Earth. However, the other five are harder to conquer, and will require a lot of planning. Food is by far the most complicated challenge to overcome, due to the limitations presented by the poor lunar atmosphere and regolith. The soil on the moon is poor in nitrogen, which is essential for plant growth, as well as other compounds required for healthy crops (carbon, phosphorus, etc.). Therefore, a large amount of these organic compounds must be transported from the earth to the Moon, adding to the total cost and fuel usage of the trip. The plants also require steady sunlight, water and a biosphere to grow in. However, once the first batch of plants (along with the nutrients) is introduced into the lunar environment, the cycle will become self-sustaining as humans grow the food, eat it, and excrete the compounds as waste. This waste will in turn nourish the next batch, and so on and so forth, creating a nutritious environment for future space pioneers on the Moon.

Water and a breathable atmosphere go hand in hand, and so if either one of them was found, then the other one would be positively impacted. A breathable atmosphere is fairly simple to obtain; the lunar soil contains oxygen, and chemicals shipped from earth that are found in the Earth's atmosphere (carbon, nitrogen, etc.) can help to create a stable Earth-like atmosphere. Water is a little trickier, however. In 2008, the Chandrayaan-1 probe successfully detected water on Moon, along with useful chemicals and the fact that the Moon has its own water cycle. However, the amount of water in the regolith is a disappointment and impediment to colonization: the astrophysicist Robert Zubrin stated that the "30 m crater ejected by the probe contained 10 million kilograms of regolith. Within these ejecta, an estimated 100 kg of water was detected. That represents a proportion of ten parts per million, which is a lower water concentration than that found in the soil of the driest deserts of the Earth." Therefore, it is more likely that future colonists will bring liquid hydrogen on a spacecraft and react it with oxygen found in the lunar regolith, most probably within a fuel cell to generate electricity and water at the same time. This would be a substantial side-benefit on a desolate and bereft of volatiles (light elements) body such as the Moon.

On the Moon, the most essential part of a colony, which decides whether a settlement can survive or perish, is power. All the other basic functions and activities that occur in or around the encampment depend on power to perform the specified actions. Therefore, it is extremely imperative that a moon base is linked up to a clean, renewable and efficient source of power. Currently, there are two main sources that can be utilized to power potential moon bases: nuclear (either fusion or fission) and solar. Nuclear power has the advantage that it doesn't depend on the conditions on the rocky body for optimal performance; with some radiation shielding and a housing area, a nuclear power plant can be fully operational and provide approximately forty kilowatts, about as much as the demand of eight homes, of power. Today, fission is the only form of nuclear power commercially available, but it produces radioactive materials that require dispensing; else, they would pose a health risk to colonists.

If and when fusion becomes commercialized, it would present an excellent energy source as it provides more energy than fission while producing fewer pollutants. Solar power is also extremely viable as colonists can take advantage of the Moon's 354 hour day. In some areas, the sun's light is always shining, providing an excellent area in which large "solar farms" could be established that could either power the base or even Earth, providing a never ending supply of electricity to the people of this planet.

The space agencies of this planet will no doubt be spending billions upon billions of dollars on outfitting and launching a small group of pioneers to our nearest rocky body, but what is the use of such an expensive and energy consuming enterprise? It turns out that the people of Earth can benefit a lot from the exploration of the natural satellite, whether it is in terms of capital, resources or scientific data. One of the major driving factors behind the moon colony is the human spirit of exploration. To cater to this, mankind has explored nearly every vestige of this planet, and so it would seem only logical that the next step is to conquer the Final Frontier through the establishment of the first extraterrestrial colony on Earth's natural satellite. Also, the establishment of colonies on the Moon could bolster tourism and revenues associated with it. Already, space tourism is starting to become a profitable business, and this will no doubt increase with a colony on the moon, as people will be intrigued by the variety of sights on the moon and beyond. This will develop a lunar economy, which can effectively trade products that can only be found or made on the Moon with Earth if the moon reached a state of development such that it is self-sufficient in all other aspects of life. In a scientific perspective, the impacts of a moon base are colossal. Since the moon has no atmosphere and low gravity, it could offer both a staging ground for future trips to other planets (no atmosphere means no resistance, so the rocket does not have to utilize a lot of fuel to leave the moon). It also provides a spectacular view of the universe that cannot be matched on Earth, as well as an abundance of formations that could be of scientific importance. The moon also provides scientists with an area to see the prolonged effects of space on humans and whether or not humans can live and reproduce in a low gravity environment. This will be a crucial element when the time comes for a complete shift to living in space, as it will guarantee the survival and thriving of the human species as it continues to conquer the Final Frontier.

The colonization of the moon is critical for the continuation of mankind's exploration of the Universe. It is from this that the human species can venture out to control and utilize other heavenly bodies to further the scientific, social and economic goals that can make mankind a true brilliance in the dark Universe. All that it requires is for several men and women to return to an alien and inhospitable world and take the first steps into a new era in human achievement.