

Thesis Project Portfolio

Mechatronic Orrery Capstone Project

(Technical Report)

Ethical Framework for Space Travel and Colonization Research Paper

(STS Research Paper)

An Undergraduate Thesis

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Introduction

The following portfolio contains two projects, a capstone project and a sociotechnical research paper that each explore different aspects of space exploration. On one hand, the capstone project looks to improve education around the physics of space and orbits, while the research paper looks to examine and refine the ethical approach to space travel and colonization so that key decision makers in the industry can advance space flight and colonization in an ethical and moral way. While the capstone project demonstrates the gravitational interactions between the celestial bodies in the solar system, the research paper examines the historical and existing interactions between ethics and the motivations, technologies, and sociopolitical factors within the realm of spaceflight and colonization to create a new set of ethical principles inside of a framework to achieve ethical spaceflight.

Mechatronic Orrery Capstone Project

The technical project involved the creation of a mechatronic Orrery. Since their invention, Orreries have been used to educate the general population about how our Solar system functions. Orreries are mechanical models of the Solar System that represent the positions and motions of the planets and moons. A mechanical arm can be moved so that accurate movement and positions of the planets can be shown. However, traditional orreries are created with complicated gear ratios and lever arms stemming from a concentric shaft. The limitation of a purely mechanical and gear-driven design is that you cannot look into the future very far, unless you plan on spinning the gears hundreds and thousands of times, which is prohibitively time-consuming. Additionally, traditional orreries are inefficient and lose accuracy as you continue to

spin the planet because of limitations in relying on gear ratios to model complex orbital movements.

The mechatronic orrery project has created a more versatile, aesthetically pleasing, and accurate model of the Earth, Moon, and Sun than traditional gear-driven orreries. The purpose of creating a mechatronic orrery was to demonstrate in a unique and fun way the positions of the earth and moon relative to the sun, while helping people visualize the movement of these heavenly bodies in relation to each other and how their movements determine things like seasons, moon phases, eclipses, and so on. The mechatronic orrery includes a sun, an earth, and a moon that rotate around the sun, with a lighting fixture in the sun that shines light on the earth and the moon to show how the seasons are made relative to the earth's atmosphere and a rough estimation of how the phases of the moon are created. The orrery also includes an electronic display that shows the phase of the moon, the date, and the position of the earth. There are two modes to the orrery: one where it rotates on its own, and the other where the user inputs a date, and the orrery automatically rotates to show the earth and moon's position at that time.

Ethical Framework for Space Travel and Colonization Research Paper

This research paper explores the ethics of space travel and colonization in order to develop a rigorous ethical guide for key decision makers in this area. Lessons learned from the history of exploration, colonization, and migration can be used to refine the ethical code of exploration and colonization. Through which ethical lens should the key decision makers that lead humanity's exploration of the Moon and Mars use in order to make decisions that lead to the greatest benefit for humanity? In order to answer this question and create this ethical code, an understanding of why organizations around the world are working to expand space travel as well as the technology being used to accomplish this is necessary. In particular, the Deontology and Technological

Momentum STS Frameworks are used to understand the motivations behind space travel as well as how current technology has and will interact with socio-political factors to progress space travel. Data is organized based on the current goals and priorities of space agencies and related organizations, along with historical research on previous colonization and space travel endeavors. This research paper contributes to existing STS and Sociology literature by connecting the history of space travel and other colonization missions to the novel present state of space travel. The research paper will support the construction of a more ethical and time-lasting set of ethics onto which the future of space flight will rest.

Conclusion

Working on the Mechatronic Orrery capstone project and the Ethical Considerations for Lunar and Martian Colonization research paper simultaneously provides a unique and valuable opportunity to consider two different aspects of space exploration. These projects are complementary, as they demonstrate how technological advancements in space exploration need to be balanced with ethical considerations. Furthermore, this simultaneous process has given me the opportunity to focus much of my time and thought towards space and spaceflight. In many ways, both projects have indirectly benefitted because of this focus as I have spent more time thinking about space and spaceflight, including the technical and socio-political challenges associated with advancing the field in an efficient and ethical way into the future.