In his 1987 text *Introductory Nuclear Physics,* professor Kenneth Krane explains the principles of nuclear technology in the following manner: "No other field of science comes readily to mind in which theory encompasses so broad a spectrum, from the most microscopic to the cosmic, nor is there another field in which direct applications of basic research contain the potential for the ultimate limits of both good and evil." Such a statement can have a galvanizing effect on an undergraduate student as he or she first begins to study the fundamentals of nuclear physics because the same nuclear methods used to create destructive weapons may also be used to advance medical imaging and cancer treatments, energy production for homes and automobiles, consumer product testing and research and development of common goods such as medicines, batteries, microwaves, computers, televisions and cameras. Thus, when given the opportunity to apply a nuclear approach to human space exploration, I was enthusiastic about doing so.

Nuclear weapons are rarely thought of having a purpose outside of a frightening and ruinous role. In the 1950's, however, a group of American scientists began to perceive of them as a source of power for propelling rockets in space: by absorbing the energy released in a nuclear detonation, a distinctly engineered spacecraft would be able to increase its velocity without expending massive amounts of fuel. The potential for such a spacecraft to propel humankind throughout the stars was remarkable, and the newfound purpose for a stockpile of deteriorating weapons was extraordinary. In fact, the United States Department of Defense and General Atomics Corporation poured millions of dollars into the project as well as a decade of time and manpower. The Castle Bravo thermonuclear test even incorporated a structure to prove that manmade structures could survive a nuclear fireball, and the strategy for delivering a manned mission to Mars was approved. The Soviet Union had no comparable project, and when the 1963 Treaty Banning Nuclear Weapon Tests In The Atmosphere, In Outer Space And Under Water was negotiated, the politics of the Space Race ultimately shelved the project indefinitely.

Engineering was still needed for the program–named Project Orion–specifically in the area of electromagnetics. When a nuclear device detonates, it ionizes all of the matter around it, which in turn produces an electromagnetic pulse: this phenomena could be potentially devastating for any spaceship that would ultimately depend upon electronics for navigation, life support, or communication. By the time Orion was abandoned, more time had been devoted to the feasibility and mechanics of the design rather than EMP production and shielding. Furthermore, experimentally verifying a quantitative value for the voltage produced during such a blast would be impossible with the nuclear treaties currently in place if the project were recommissioned.

For over a year, I have taken the available data from previous nuclear detonations–such as *Starfish Prime*–and applied a unique computer analysis to research this problem at the Western Kentucky University Applied Physics Institute. My distinctive method of simulating a nuclear impulse-driven spacecraft in Monte Carlo N-Particle Transport Code, converting photons into electrons, and using the resultant data to calculate the induced potential with COMSOL Multiphysics has continually verified the data from these previous Earth-based blast data. As such a process has never been undertaken before, I was forced to begin my research analysis from first principles, overcoming atmospheric data, material limitations and definitions, as well as estimated nuclear yield data from classified bomb tests. As a result, this has shown that my atmospheric model is quite robust, and that the simulated vacuum model is feasible. Furthermore, my research has quantitatively shown the earlier predictions of no induced voltage made by General Atomics were incorrect, and that several volts can be generated across the surface of the spacecraft depending upon the amount of mass and the yield of the detonation.

This research has given me a new insight into the potential of human presence amongst the stars, as well as newfound respect for nuclear physics in space. Moreover, I have endeavored to share my results with colleagues and peers, and have thus presented at a multitude university and regional talks, and I am also being prepared for publication in the Journal of Undergraduate Research in Physics. Currently, my model is being used to quantify the electric potential induced on pacemakers and solenoids to better shield electronics from electromagnetic pulses.