Recently, I have been developing my research interests through participation in several projects. Last summer, I participated in an internship program at NASA’s Langley Research Center (LaRC) in Hampton, Virginia. This opportunity, arrived at through my involvement with the NASA-ASEE Aeronautics Scholarship Program, placed me in a NASA laboratory with a research scientist who functioned as a mentor. I was placed in the Nondestructive Evaluation Sciences Branch of the Science and Technology Directorate, working with ultrasonic transducers. This was not work with turbomachinery, as I had hoped, but I embraced this divergence as an opportunity to broaden my areas of interest and understanding.

It was not long before I realized how applicable my summer position would be to my future as a researcher. Specifically, I gathered information on the frequency dependence of diffraction patterns from ultrasonic transducers. Furthermore, I utilized these data to begin the design phase of array transducer configurations capable of interrogating materials and returning results independent of beam-width effects. The motivation for such an array configuration comes from the difficulty of adequately interrogating composite materials composed of three-dimensional textile-based materials (in particular, three-dimensional braids and weaves).

The concept of this project was something that my mentor, Dr. Patrick Johnston, had conceived early in his career at LaRC (nearly 25 years ago). Upon my arrival at LaRC, though, research had yet to begin on the project. Over the course of the summer, I was closely involved with other research interns who were working in similar programs. However, my situation differed significantly from theirs, for one primary reason: from the very beginning, I spearheaded the project to which I was assigned. The projects of many of my peers had been ongoing for years prior to their arrival, and they were able to make only a small contribution somewhere in the middle of the project development. I can honestly say that all of the progress on my project throughout the summer was the direct result of my work; no other researchers, civil servants or students performed any of the data acquisition or analysis, or wrote the reports.

Understandably, some of the research involved material I was still learning, but my mentor was able to provide me with some of the more advanced physics governing the phenomena I was observing. Moreover, when it came to analysis, my mentor’s presence was paramount in assisting me with interpreting the results, although I was solely responsible for collecting and analyzing the data. I selected the transducers for the experiments, calibrated and ran the data collection systems, and analyzed the data that were reported in the end.

In particular, I worked with a carefully selected assortment of transducers representing various diameters, frequencies, and focal lengths. With each transducer, I proceeded to analyze three materials: an acrylic specimen, a quasi-isotropic laminate with 65% fiber volume fraction, and a three-dimensional braded textile-based composite. A tank of water was used as the liquid coupling agent for the transducers and a computer-controlled X-Y-Z scanning bridge was implemented to move the transducer in pre-defined, computer-controlled interval steps. From this set of data, values for attenuation in decibels were acquired. In conjunction with the water tank scan data, an OptiSon Beam Analyzer system was employed to investigate the frequency dependence of the ultrasonic beam widths.

Through this expansive data acquisition process, I investigated the interdependence of frequency, attenuation, and beam width as it relates to the three different materials investigated. The process of extracting this interdependence, though, was not at all easy. It was necessary for me to create countless plots relating multiple parameters in different manners (i.e., plotting results from different transducers and similar materials versus plotting results from different materials and similar transducers). As a result of the difficulties observed throughout this
experience, I have a newfound respect for and understanding of the general process that composes “research.” I now realize that research involves acquiring data, re-acquiring data, and re-acquiring data yet again. In the initial days of my summer experience, my mentor exposed me to the idea that a majority of my relevant data would most likely be acquired within the last weeks, or even days, of my internship tenure. However, I was skeptical of this statement until I realized its validity; the plots that I used in my final report were created the day before the report deadline.

Overall, the amount of knowledge that I was able to take away from my experience at LaRC was remarkable. I felt as though I produced beneficial results, showing evidence that there is indeed a significant interdependence of interrogation frequency, ultrasonic beam width, and signal attenuation visible in three-dimensional textile-based braided fiber structures, which is not present for quasi-isotropic laminates. Aside from my experimental results, and perhaps more importantly, though, this knowledge shaped my understanding of the research process – giving me a much better understanding of what I can expect from my time in graduate school and beyond – and I definitely expanded my knowledge of physics along the way. In addition, I have recently taken my summer experience a step further and connected it to my interest in aerospace propulsion through a project under way at Syracuse University.

In my final year at SU, I am assisting Kerwin Low, a Ph.D. candidate working in the Department of Mechanical and Aerospace Engineering. I have been able to help Kerwin in calibrating data acquisition systems and preparing experiments. His project is researching closed-loop flow control techniques as a method of attenuating far-field noise created by acoustic pressure fluctuations from high-speed jet velocities. A silicon glove device, outfitted with a series of piezoelectric disks, is attached to a high-speed jet nozzle. By analyzing the turbulence propagating from the jet nozzle, Kerwin is working to create new, forced waveforms which act out of phase with the turbulent sound waves, thereby attenuating the noise as it is experienced in a far-field environment. The results of this research are of considerable interest for airfield environments, particularly in urban areas. If a system such as this could be produced for use with general turbofan exhaust nozzles, significant reductions could be made in the noise pollution created in the vicinity of airports.

Finally, I am currently participating in a group design project as part of my degree requirements for mechanical engineering. For this project, my group is designing a self-sustaining light pole, capable of off-grid operation. This project implements a vertical-axis wind turbine and photovoltaic solar cells to harness natural energy, which is converted into power for low-power LED lights. My contribution to the team is the selection of the rotor type and optimization of the rotor parameters. This process is leading me through countless journal articles on the topic of Savonius- and Darrieus-type rotors, both of which have been researched at length over the course of the last century. I am researching the process of matching turbine power production with an appropriate permanent magnet generator and methods for properly analyzing incremental wind data.

The projects that I have been involved with in recent years have provided me with considerable knowledge on the topics of project development and research. However, I am yearning to continue my development as an engineer and a researcher through future projects. In light of global warming and the world-wide dependence on fossil fuels, I foresee an increase of demand for environmentally-friendly alternative energy solutions. My hope is to be able to have a positive impact on peoples’ lives, and I anticipate the research and development of such energy technologies to be an ideal way for me to accomplish this goal.