Studying Electrical Engineering as an undergraduate has given me a fundamental and applied understanding of modern computing technology, from the smallest level of PN junctions to the largest level of global networks and signal processing. As we are approaching the physical limit on the miniaturization of transistors, it will soon be necessary to combine or replace conventional electrical engineering concepts with innovative and interdisciplinary approaches in order to keep up with the precedent set by Moore’s Law. Some of the current contenders for the future of computing include carbon nanotube transistors, quantum computing, and neuromorphic architecture. As stated by the influential computer pioneer, Alan Kay, “the best way to predict the future is to invent it.” I anticipate that neuromorphics will be a significant player in the future of computing, and I plan to be involved in the development of this technology. Because of its low power consumption, massively parallelized data processing, and ability to use implement heuristics at the hardware level, neuromorphic computing has inherent advantages that make it superior to alternative technologies in various applications. Specifically, it will be a powerful vehicle for enabling the two changes in the world that are most important to me; making humans an interplanetary species and improving personalized education.

It is impossible to work at SpaceX and not dream about the future of humans in space. Spending months around all kinds of rocket parts, from small circuit boards and sensors to massive fuel tanks and Dragon capsules, gave invaluable real-world engineering experience and tremendous joy. Working alongside the brightest engineers and scientists has only intensified my long-term goal of helping humans become an interplanetary species. While there, I worked on various hardware and software systems on Falcon 9 and the development vehicle in Texas. I learned that one of the current challenges with deep space exploration is that radiation has the ability to flip bits and corrupt data. Modern CPUs are highly susceptible to errors in the way data is bottlenecked through the processor without much redundancy or parallelism. However, neuromorphic architecture would have an inherent advantage over traditional CPUs in this application, as it not only processes data in massive, parallel networks at the hardware level, but it also consumes a fraction of the power. I see the invention of this new technology as crucial to the future of space exploration.

On the other front, I have already actively begun tackling my goal of advancing personalized education. As seemingly unrelated as it may sound, I have been a “joggler,” or runner who juggles, for many years before ultimately training and setting a few world records. After my first year in college, I decided to use the publicity from two world record attempts, the fastest 5km and 400m while juggling 5 objects, to raise support for the primary school and children’s home in Rhotia Valley, Tanzania. The village was introducing One-Laptop-Per-Child devices into the education system to allow young kids to connect with the world, gain experience with computers, to satisfy their own curiosity, and become members of the 21st century global community. From a cultural perspective, I found this program inspiring and wanted to get involved, as it aligned with my personal values. From a technological standpoint, I was excited to see low cost, efficient, and well-designed technology be applied constructively to solve problems.

I was ultimately successful in setting the records, but this project represents merely the tip of the iceberg of my goal to improve global education. According to the National Academy of Engineering, one of the greatest challenges of the future is advanced personalized learning. I believe that much larger revolutions in education are on the horizon as technology advances. Simply equipping children with an encyclopedia with the entire collective knowledge of the human species (the internet) is not enough. While a human teacher can presumably provide a student with the necessary customized education, this is not a logistically feasible way to broaden access to personalized education. There are countless students worldwide who are very passionate about certain subjects and would benefit greatly from having access to truly personalized education. Neuromorphics could be an important enabler for this, as it will allow for more accurate and computationally feasible methods of assessing a student’s abilities and knowledge as well as providing a more effective and adaptive processes for presenting information.

Personally, I have been very fortunate to have an eclectic history of research, internship, and life experiences that led me to converge on these specific goals and interests. Each project and activity that I worked on as an undergraduate has been a stepping stone that helped point towards true interests, even though they may seem unrelated at first glance.

My first research experience was at Pennsylvania State University through an NSF-sponsored REU program, designing and building MRI microcoils for imaging individual cells. Here I learned about circuit resonance and design, as well as basic laboratory procedures and research methods. I had the chance to get technical experience working with 7T and 14T MRI coils and designing my own circuit boards. These boards employed Helmholtz coils with voltage-controlled resonant frequencies via varactor diodes. Although I found this project interesting and fun, it often left me wondering what research at the more fundamental level is like. For this reason, I decided to scope out nanomaterials work that would give me this experience.

The next summer, I was accepted into the NanoJapan REU through Rice University. Not only did this program give me the chance to pursue my emerging interest in materials science, but it also let practice my Japanese skills that I had been practicing for years inside and outside of the classroom at the University of Florida. However, the Fukushima incident caused my stay in Japan to be cut short. I conducted my actual research in the Ajayan Lab at Rice University and I gained a lot of hands-on experience working with graphene and other nanomaterials for energy storage applications. Furthermore, being at Rice University gave me the opportunity to pursue a bit of inspiration I gained while in Japan.

I spent one weekend that summer in Minamisanriku, a small village that was devastated by the Tohoku earthquake and tsunami. One of the most memorable parts of the trip was when one of the elder men in the town told us (in Japanese), “when you return to the big cities in America, do not forget about us. The media forgot about us but we are still struggling.” This moment galvanized me into taking action like I did for Rhotia Valley the year before. Though the training process was the most physically taxing feat I’ve completed to date, I was ultimately successful in running the fastest mile while juggling five objects and helping to raise awareness and support for the community in Minamisanriku. This experience also infused me with some invaluable character-building moments, such as was when I did a live radio interview for a Minnesota station whose premise turned out to be humiliating their guests. The experience of candidly responding to their malicious banter and demeaning of the situation in Minamisanriku with composure and eloquence was a turning point in my personal growth. It was the most piercing antagonism I have ever received in my decade-long joggling career, but taught me the importance of strong commitment and leadership.

Immediately after completing this REU at Rice University, I was offered a position at my dream company, SpaceX, and took off time from school to pursue it. This juxtaposition of fundamental scientific research and product-oriented industry work within the same year had a profound effect on my academic trajectory. While research at Rice was exciting and cutting-edge, seeing my work launch to space at SpaceX was enthralling. However, in antithesis to the way that research at Rice was occasionally frustrating and slow, work at SpaceX moved at such a dizzying rate that the biggest challenge became managing the stress. That year, I decided that materials science, though fascinating and full of potential, was not a field that I would enjoy spending the rest of my life in. Similarly, Avionics Integration did not involve enough electronic design and creativity to satisfy me.

One of my SpaceX projects, however, was instrumental in shaping my interests. I worked on the thermal imaging systems that monitor temperatures of the engine nozzle on the second stage of the rocket. This sparked a heavy interest in photonics and led me to take a specialized Photonics class at my university and participate in another REU, the Optics in the City of Light program through University of Michigan. My project was designing and characterizing a full-field optical coherence tomography setup that could be coupled with optical tweezers for cell-level biological studies. Although I found this to be the most interesting and exciting work up to that point and thoroughly enjoyed the international atmosphere, I was still not satisfied settling on photonics as a career. Some of the side tasks that this project called for, however, fueled my developing interest in computer science and information technology at the time.

I returned to SpaceX the next summer in the Hardware Development and Test Software group to gain more industry experience working on the hardware-software interface and circuit design. Although by the end of this internship, I had decided that SpaceX is not where I want to establish my career, one of the projects I worked on employed machine learning algorithms in order to automate certain parts of the rocket design process. I thoroughly enjoyed developing these software tools and continued to learn more about the subject. This led me to join the Machine Intelligence Laboratory at the University of Florida for the end of my undergraduate career to gain more experience with unsupervised learning and computer vision. I am currently developing SLAM algorithms for the university’s robot in the IEEE autonomous robot competition. I found this work intellectually stimulating and a great introduction and source of inspiration for the potential of neuromorphic engineering.

Overall, I am very fortunate to have had been able to follow such a wide variety of interests as an undergraduate. My personality and character have undergone severe battering that left me feeling stronger every time. I cannot imagine what I would want to study more than electrical engineering, as I feel that it is gearing me to be able to tackle the goals that I truly and passionately care about. If the past century has been any indication of how science changes the world beyond imagination, then the next century will be full of exciting new technologies that I want to be part of.