

## **Personal Relevant Background and Future Goals Statement Outline:**

### **Introduction:**

At the main entrance to the Brigham Young University campus stands a sign bearing the following message: *Enter to learn, go forth to serve*. That's how I feel about my education. It's a means by which I'll be enabled to do great good in the world. I want a career that will allow me to help other people, provide for my family, push past the frontiers of current scientific knowledge, and continually learn. Pursuing a graduate degree will help me achieve these goals.

### **Motivation and Preparation to Attend Graduate School:**

As a ten-year-old, I thought *engineer* meant train-driver. By the time I entered college, I still didn't know much about engineering, but my friend's father had told me I'd be a good engineer. I decided to give it a shot. Since that time, I have had numerous experiences that increased my motivation not only to remain in the mechanical engineering program, but also to go beyond an undergraduate degree and pursue advanced research. Following are some of the key experiences that have prepared me for graduate school both by shaping my desires and giving me valuable skills and experience:

#### ***Research in the BYU Partners for the Advancement of Collaborative Engineering (PACE) lab – 2013***

I initially took a job in the PACE lab as a software tester, to help with the development of a multi-user CAD system. The goal of our research was to develop a 3D modeling environment in which engineers could collaborate in real time. On top of the software testing, I worked with a team of six students in designing, building and flying a

blended-wing UAV. I had the solo responsibility of designing the aerodynamic surface.

To say that I enjoyed the challenge is an understatement—I absolutely loved it.

Through many weeks of research and hard work, I produced the *Parametric Wing Skin Generator*, an Excel spreadsheet designed to instantly calculate the defining 3D spline points of almost *any* blended-wing aircraft based on user-defined parameters. I also developed several macros to insert the spline points from Excel directly into the CAD program. We successfully built and flew our UAV with one of the wing skins I designed. This was my first experience with programming of any kind, and I was hooked. I started my computer science minor the very next semester. The PACE lab helped me to discover a deep-seated passion for research, problem solving, and computer science.

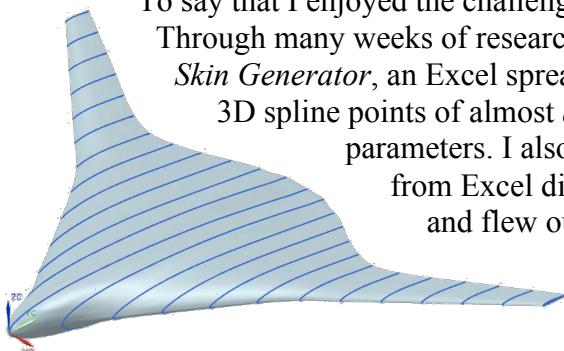


Figure 1 - a wing skin generated by my spreadsheet

***The Los Alamos Dynamic Summer School – 2014*** – I applied for the Los Alamos Dynamic Summer School because of my interest in cyber-physical systems. During this nine-week program, I worked with two other students: one electrical engineer and one civil engineer. We designed and implemented a two-stage structural health monitoring system to rapidly detect, localize, and characterize damage in plate-like structures. We tested the system at the Sandia National Laboratories Aging Aircraft Facility, with great success. Our research was published as an IMAC conference paper<sup>[1]</sup>, and has demonstrated potential to improve structural health monitoring of aircraft. I gained lots of experience with statistical digital signal processing, guided wave physics, structural health monitoring, and cyber-physical systems in general. The biggest take away for me, however, was an appreciation for the value of interdisciplinary expertise. I was inspired by the breadth and depth of expertise demonstrated by many of our mentors at the LANL Engineering Institute.

**Summer Research at the Los Alamos Engineering Institute – 2015** – Last summer I returned to the Engineering Institute to work on a project with my previous year’s mentor, Eric Flynn. Our goal was to develop a handheld version of the R&D-100-award-winning Acoustic Wavenumber Spectroscopy (AWS) system that Eric originally helped to develop. I was part of a team with three other students, although all of my work was done alone. My tasks were (1) design and build a prototype hand-held system and (2) devise a method to reconstruct scan data and overlay it on a 2D image (or series of images) of the scanned structure. I built a working scanner prototype and used the open source computer vision (OpenCV) library to successfully implement several different image-tracking algorithms for reconstructing and overlaying the scan data in 2D. Our research will be published in early 2016. Through this research at Los Alamos, I discovered a deep interest in computer vision and image processing. I also became quite preoccupied with the idea of trying to overlay ultrasonic scan data on a 3D model of an object. It was this experience at Los Alamos that led me to the research I hope to pursue in graduate school: designing and implementing an aerial ultrasonic scanning system to rapidly inspect critical structures like aircraft and wind turbines.

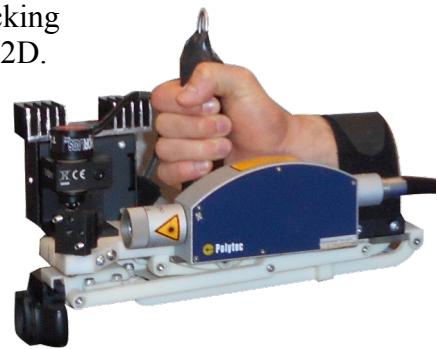


Figure 2 - my prototype handheld scanner

**BYU MARS Rover Project – Current** – I’m currently the student leader of the BYU MARS Rover team. We are designing and building a rover to compete in the Mars Society University Rover Challenge, which will take place in June of 2016. The URC “challenges student teams to design and build the next generation of Mars rovers that will one day work alongside astronauts exploring the Red Planet”<sup>[2]</sup>. I applied and received an offer to be a part of the team, and was excited to learn that we would need some of our mechanical engineers to play the role of electrical engineers. Accordingly, I have found myself in a position to help develop the controls and communications systems for the Rover and am the resident expert on computer vision. We are using the Robot Operating System (ROS) to develop our controls and

communications systems. I’m excited to gain experience both with ROS and with programming embedded systems (I’ve already done some through my classes). Both of these skills will prove invaluable in my graduate research.

The MARS Rover is a very iconic project. We’ve had the chance to display the Rover at Homecoming parades, important alumni meetings, and BYU lab exhibitions. In every case, the end result among those who see the Rover in action is the same: increased excitement about engineering. We’ve also been able to give younger students a



Figure 3 - the BYU MARS Rover

chance to contribute to the project. The Rover is an excellent tool for outreach, and we plan to continue using it to generate excitement about engineering.

#### How grad school will prepare me to contribute to expanding scientific understanding:

I plan to pursue a PhD at UCSD in Structural Engineering, under the direction of Dr. Michael Todd. Dr. Todd’s lab is widely known for its work in ultrasound, Non-Destructive

Evaluation, optics and UAVs. By design, the Structural Engineering degree at UCSD incorporates a large component of electrical engineering coursework and research. I will be able to tailor my coursework to fit the unique needs of my proposed research. In my case, this will include many classes in control theory, robotics, computer vision, and embedded systems.

**Continued Interdisciplinary Research:** Thanks to the Structural Engineering program's strong emphasis on interdisciplinary expertise, and to the diverse nature of my proposed PhD research, I will graduate from UCSD with a wide range of valuable skill sets. After graduate school, I hope to spend several years working at the Los Alamos National laboratory, or one of the other national labs. I am also interested in eventually working for (or starting) a robotics or other tech company focused on cutting-edge research. I am convinced that interdisciplinary expertise will be a valuable "tool belt" in enabling me to collaborate with other scientists and solve important problems. Some of the fields that I find particularly interesting are medical robotics, medical imaging, and (obviously) advanced non-destructive evaluation technologies.

### **How grad school will prepare me to broadly benefit society:**

**Giving Back:** Doing something I love is more important to me than a lucrative salary. However, I hope to eventually achieve a degree of financial success that will enable me to provide scholarships to students. Having personally benefited from a substantial amount of financial aid, I would be honored to be able to give back. Thanks to the generosity of scholarship donors, I don't have even a penny of student debt. I want to provide a means of funding the education of students (especially those pursuing technical degrees) who are willing to work hard.

**Teaching:** Eventually, I want to be a university professor. I am deeply grateful for the teachers in my life who have inspired me to continue my education. I hope to do for other students what my professors have done for me. On top of that, I genuinely love teaching. Working at a university would be ideal because I could pursue advanced research and encourage students to join in the effort. I will encourage students to develop similar interdisciplinary skills to those that I will have gained at UCSD.

**Volunteering:** I have given many hours of volunteer service over the course of my life. In Boy scouts, I completed my Eagle project by erecting a flagpole in a community park. I spent two solid years (2010 – 2012) as a volunteer missionary for the Church of Jesus Christ in France. During that time, I taught people about Jesus Christ, participated in regular organized service activities, and came to love the French people, language and culture. Through my involvement in BYU athletics (I'm a pole vaulter on the track team), I have had many opportunities to volunteer at community races. My favorite so far has been the "Hope for Kids" race for children with disabilities. I'm currently waiting on the opportunity to volunteer at the robotics/engineering club at a local high school (the club hasn't started yet). Both during and after graduate school, I plan to give of my time, resources, and expertise.

"Education is the difference between *wishing* you could help other people and *being able to help them*"<sup>[3]</sup>. That's how I feel about the opportunity to attend graduate school. I genuinely want to engage in activities that will both contribute to scientific knowledge and benefit individuals in society. I am confident that my chosen path of study will prepare me to do so.

[1] Gannon, Brown, Flynn, Warren, Wheeler, (2014). *A High-Speed Dual-Stage Ultrasonic Guided Wave System for Localization and Characterization of Defects*, IMAC XXXIII

[2] MARS Society Home Page - <http://urc.marsociety.org/home/about-urc>

[3] Russell M. Nelson, "What Will You Choose?" <https://www.lds.org/liahona/2015/01/what-will-you-choose?lang=eng>