I entered the University of Washington as a freshman three years ago. My experience at the UW has been so rewarding. As I plan to graduate in June, I find myself appreciating the opportunities I've had to prepare for my career. I have been involved in a few activities and programs across campus that gave me social, academic, and leadership experience. Currently I'm in the University Honors Program, a Husky Football season ticket holder, in the National Society of Collegiate Scholars, and president of the Biomedical Engineering Society at UW. My journey as an undergraduate has also brought me to several research and lab experiences; however, I only recently found a project I am truly passionate about. I started in Dr. Sarah Keller's lab (Chemistry) as the "resident engineer," designing and building equipment to help lab experiments run more efficiently. I left the lab to pursue research in my major. As a Bioengineering student, I am interested in projects that will advance the field of medicine. I therefore joined Dr. Paul Yager's lab and began working on drying reagents onto membrane substrates while maintaining their functionality. The results would eventually be used for malaria testing. Though I valued my experience working in a wet lab, I desired to invest time in a project that could be immediately applied to surgery. I learned of a surgical concern in the field of orthopaedics and decided to take on this new project last May.

In collaboration with the UW Medicine Department of Orthopaedics, I will be designing, building, and testing a tool for use in arthroscopic shoulder surgery. One of my undergraduate professors had recommended me for the project because he knows I like thinking analytically about solving tangible 3D problems and device design. My project requires inventing a solution (drill guide) to a specific problem (repairing torn tissue that causes repetitive shoulder dislocation). Dr. Frederick Matsen III, chair of the Orthopaedics Department has agreed to advise me through the duration of the project. He will provide time to discuss with me the surgical aspects of the tool as well as space in the orthopaedics wing of the UW Medical Center to do testing on cadaver specimens. I will also be mentored by Dr. Deana Mercer (University of New Mexico) and her husband James Love (Love Systems Engineering, Albuquerque) on both the surgical and fabrication aspects of the arthroscopic tool. I find orthopaedic problems exciting and intriguing. Not only do I gain insight into how the body moves and functions, but any research I do will drastically improve the quality of life of patients with debilitating orthopaedic ailments.

Of the orthopaedic conditions, shoulder injury is common in athletes as well as persons aged 60 and over. With expected lifetimes increasing and children's involvement in sports intensifying, dislocations occur frequently. The shoulder joint consists of a ball (bone called the humeral head) and a socket (bone called the glenoid, a feature of the shoulder blade). The glenoid has a cartilage-like ring that cushions and deepens the shoulder socket (see Labrum in Figure 1). Upon dislocation the labrum may be torn (i.e. unattached), resulting in what is called a Bankart Lesion. Without repair the labrum will heal in an improper position, causing shoulder instability, increasing the risk of redislocation. The Bankart repair is done arthroscopically, meaning it is done via 3 to 4 small incisions in the skin and does not require access of the joint through a large, open, incision. Surgeons drill a series of small holes into the glenoid and implant suture anchors (Figure 2). The free leads of suture are then sewn through the labrum and knotted to reattach it to its proper location on the glenoid.

My project will find a dependable way to eliminate the use of suture anchors in labrum repair. The new surgical method will eradicate the possibility of suture anchors leading to complications, and reduce the cost of surgery. I am designing, building and testing a tool that will facilitate the drilling of a hole through the thickness of the glenoid. Sutures can then be passed through the hole and be used to tie the labrum in place. Over the summer I had the incredible experience of shadowing Dr. Mercer and Dr. Matsen both in the clinic and in the operating room of the UW Medical Center. It was thrilling to watch bloody surgeries occur just three feet away. Most of the patients I saw were 60 or older, receiving shoulder replacements due to osteoarthritis. However one patient required the same surgery at the young age of 35 (see Figure 3). He received labrum repair using suture anchors a few years prior, and now had an immobilized shoulder due to the anchors protruding from the surface of the glenoid. The protrusions caused major mechanical damage to the shoulder which could only be repaired via shoulder replacement. Overall, complications from suture anchors can also include adverse allergic reaction to the implant material or anchor loosening. In order to develop an appropriate solution, I will need to acquire the set of technical skills necessary to design, build, and test an arthroscopic drill guide.

I have planned a timeline for learning appropriate skills and producing a final product. This fall I've taught myself how to use SolidWorks, a 3D computer drawing software program. I spent some time creating a drill guide prototype shown in Figure 5. Additionally, I spend three to four hours a week in the Physics Department's Student Machine Shop Class learning how to machine metals. Winter quarter I set aside time in my class schedule to do fabrication and preliminary testing on my drill guide design. I have also acquired access to a human cadaver shoulder, providing an accurate model to do final testing of my completed tool. From the results of the cadaveric testing, I can write surgical protocol on the recommended method of repair. Finally, I will finish writing and present my senior capstone thesis.

The above described process of producing a surgical tool brings me worthy experience as a researcher. Spending time in the operating room and applying my knowledge to a tool that could actually be used for future surgeries is an unbelievable accomplishment. Furthermore, I saw various aspects of the field of medicine—from patient flow to billing insurance companies. I watched and performed physical shoulder examinations, and analyzed various medical images such as x-rays, MRIs, and CT scans. I received insight into the repertoire of tools surgeons use by being in the operating room. I am learning to collaborate in teams as well as think individually. Beyond that experience, I have acquired the applicable technical skills of computer-aided drawing, as well as metal machining. My opportunity gives me the privilege of gaining invaluable knowledge while studying a fascinating field.

The drill guide I create could drastically change or even eliminate the usage of suture anchors in Bankart repair, lowering both surgical costs and risk of complications. I am currently taking a class on engineering biomaterials. The class has brought me further insight into how materials used in orthopaedic applications must be researched to fulfill the demands of the human body. The combination of classes I've taken as well as my project has brought me toward pursuing a career in development of medical technologies. More specifically, after graduation I desire to work in a company that designs and tests various orthopaedic devices.

My project has enhanced and will continue to enhance my last few quarters as a University of Washington student. Future employers will see my experience working on the project as a valuable development of both technical and interpersonal skills. The content of my project has made me realize that although most orthopaedic ailments are not life threatening, they drastically reduce quality of life. My mother herself will need a knee replacement surgery sometime within the next ten years. By returning functionality she once had, her physical as well as mental well being can be improved.

The Mary Gates Research Scholarship will allow me to engage deeply in my project. I work as a server at a restaurant on the weekends to support myself financially. Being a full time senior in Bioengineering doesn't allow me to work the number of hours I need to set aside savings for my future. Furthermore, I would love to visit Deana, James and family in New Mexico as I did last month, but my funds are getting shallow. I would be grateful to receive the award not only for financial reasons but for the pride I have in being an undergraduate researcher. I have submitted my résumé to a few employers now, and I am looking forward to describing my experience on the project as it relates to both my personal growth and my capacity to enhance the medical field.

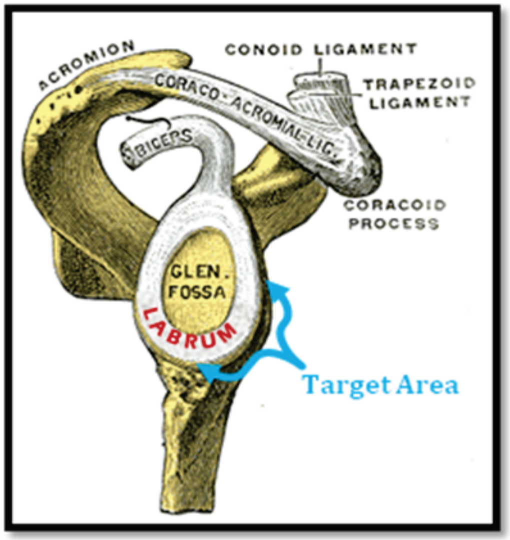

Figure 1: Glenoid and Labrum of right shoulder. 3-6 o'clock target area is where tear is most common.
Source: Gray's Anatomy Fig. 328 http://bartleby.com/107/illus328.html

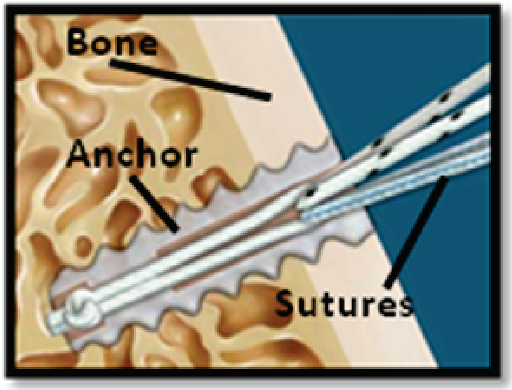

Figure 2: Cross section of bioabsorbable suture anchor in bone *Source: http://www.arthrex.com/myarthrex/brochures/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=25595*

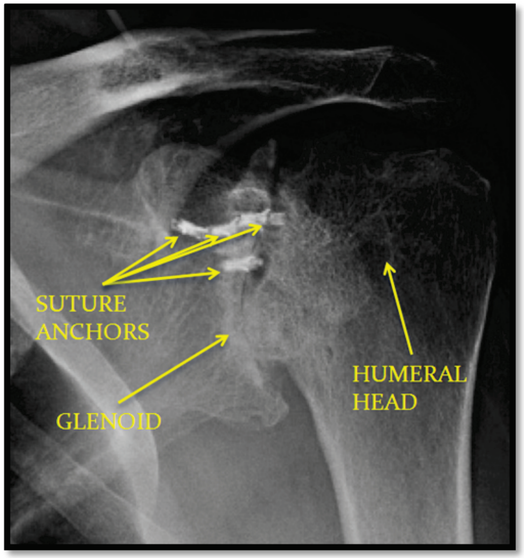

Figure 3: Pre-op x-ray of a patient's left shoulder. Suture anchors protruding from the glenoid created craters and divots on the humeral head, visible on the articulating surface. A normal x-ray should reveal a smooth and round humeral head as in Figure 4.
Source: UWMC Department of Radiology

Figure 4: Normal x-ray showing smooth, round humeral head.
Source: http://handbook.muh.ie/X-Rays/Images/XR_ShoulderAP.jpg

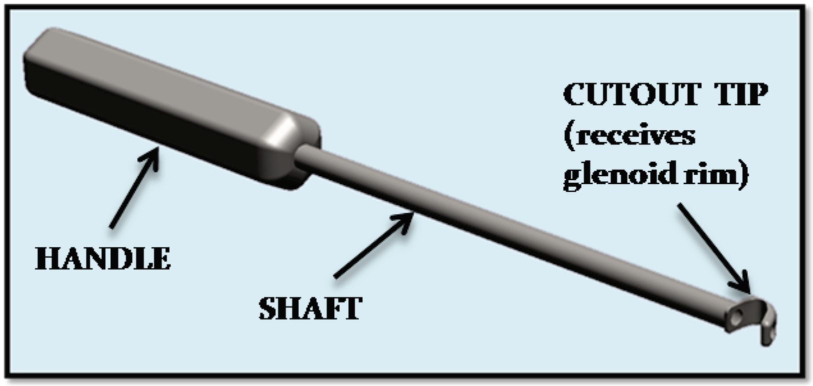

Figure 5: Prototype drill guide design.
Drawn using SolidWorks 2009 Student Edition