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Why Oxford?

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My ultimate goal in pursuing the Oxford experience is be to bring world-class Biomedical Engineering research opportunities to USAFA. The core academic strengths of Oxford's Center for Affordable Healthcare Technology (OxCAHT) and the open-source nature of their research paired with Oxford's matchless geopolitical landscape make the University of Oxford the only English-speaking university in the world with whom my research aspirations can be accomplished. As a project mentor for the FalconWorks-funded senior capstone project NeuMimic, I bring valuable experience leading a successful multi-disciplinary, systems-level biomedical engineering research project. I would come armed with valuable leadership experience paired with technical expertise in signal processing and embedded systems, thereby poised to become an immediate contributor; it is important to note that the director of OxCAHT, Dr. Gari Clifford, agrees with my assessment. Dr. Clifford, after a *very* thorough Skype interview, offered to review a research proposal for appropriateness and feasibility of completion in 3 years. The signed MFR can be found in Attachment 1 on page 3. It seems as though this opportunity was tailored to suit my strengths and interests!

There are few fields that offer more inspiring opportunities for systems-level research as biomedical engineering, especially the field of diagnostics. Diagnostics is a very challenging discipline as it usually involves prohibitively expensive and immobile equipment that regularly forces patients to travel great distances at great cost in order to access care. These traits currently inherent to medical diagnostics regularly exclude certain populations from receiving proper treatment. Affected populations can range from military members operating in an expeditionary environment to rural communities, especially in the developing world. My proposed research seeks to develop solutions to the critical need for point of care devices that are cheap, power-efficient, reliable and transportable. The immediate impact of this research is clear: it will allow individuals to access healthcare that otherwise would not be able. Oxford's centuries-old geopolitical affiliations allow this type of research to progress at a pace unrivaled at any other university or center. This is proven by the expectations of the program, which involve identifying a real-world diagnostic shortfall, creating a novel solution to fill the need as well as conducting clinical trials all within the standard 3 year time frame necessary to complete the degree. There is simply no other place on earth where research of this type can progress from idea to human trials within this relatively short time frame. While it is important to emphasize that this is exciting research, it is also important to highlight where USAFA Cadets fit in.

OxCAHT follows a research model based on the mission of Engineering World Health "to inspire and mobilize the biomedical engineering community to improve the quality of health care in resource-poor communities of the developing world" (www.oxcaht.org) . The "mobilization" aspect of the above mission statement effectively created a desire within the Biomedical Engineering community to take the handcuffs off traditional academic research. This has been accomplished by embracing an open-source paradigm for conducting research. The result of this paradigm is the creation of a "Wikipedia" for biomedical engineering research called PhysioNet, which is an

open-source repository of academic endeavors to which anyone may contribute. This repository is predominately comprised of computer source code and raw diagnostic data but also contains hardware schematics, mechanical drawings and other documentation of studies, technologies, and data contributing to the field of biomedical engineering. The open-source nature of this research is particularly interesting when incorporated with the research climate of USAFA.

The director of OxCAHT is in a unique situation. He is in a position to make immense contributions to the wellbeing of entire populations, but he needs help. Particularly, he needs help designing and implementing embedded solutions to a plethora of diagnostic shortfalls. His center does an amazing job identifying shortfalls and creating advanced algorithms that use state-of-the-art machine learning and brilliant signal processing techniques to properly analyze diagnostics data, but what he is missing is a team of undergraduates willing to implement the OxCAHT solutions in hardware so that they can be tested in the field. This is where USAFA Cadets come in. Once a partnership is established between Oxford and USAFA, cadets could expect to create hardware platforms that make OxCAHT's advanced processing techniques work in real life. These devices could then be transferred back to Oxford, where they will be administered to real patients by Oxford researchers.

Developing a research partnership between Oxford and USAFA based on open-source technology is a relatively simple process to navigate, in fact I already have. I have garnered approvals through Col Kraus, USAFA Office of Research, and the USAFA Judge Advocate for the research partnership I have proposed (the approvals can be found in Attachments 2 and 3 accordingly). Oxford-level research opportunities can exist at USAFA, not as an arcane future promise, but as a detailed plan that begins with choosing me for the Dean's Oxford Scholarship. Not only am I the best candidate to develop and pursue these exciting research opportunities, I am also the best candidate to bring these opportunities back to USAFA and inspire a new generation of cadets dedicated to making tangible contributions to the health and wellbeing of their fellow man.

I want to state unequivocally that my assignment at USAFA has easily been the most rewarding experience of my career. I am truly passionate about the USAFA Mission and I believe there is no greater professional fulfillment than to see the sheer magnitude of positive influence and inspiration an officer can have in a cadet's life. I've found that this is accomplished through tireless devotion in and out of the classroom. My first tour has taught me to appreciate the immense responsibility associated with shaping and motivating America's future leaders, and it would be a privilege and an honor to be trusted with that responsibility again by selecting me to bring Oxford-caliber opportunities back to USAFA as a senior military faculty member.

My resume clearly illustrates that I have thrived during my time in DFEC as I have won every award the department has to give as well as garnered national level recognition as the Great Minds in Stem Most Promising Engineer of 2013, but there is no formal record of the 3 accolades I hold most dear: I have been afforded the opportunity to participate in the culmination of the USAFA Mission through administering the Oath of Office thereby commissioning 3 cadets into Active Duty. When considering who should administer the Oath, cadets are instructed to select the officer whose inspiration had the greatest impact on their development and whose leadership they would most like to emulate. It is humbling to consider that these (now) Lieutenants in the classes of 2011, 2012 and 2013 selected me to be a part of the zenith of their USAFA careers and the arbiter that bestows upon them the prize for which they have worked so hard. Ultimately my personal commitment to the USAFA Mission has been recognized by my fellow faculty and endorsed by cadets, whose interests USAFA exists to serve. Choose me for the Dean's Oxford Scholarship and the real winners are the cadets.

Gus Jones!

1 Attachment - Approved Oxford Research Proposal

DEPARTMENT OF THE AIR FORCE
THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
USAF ACADEMY, COLORADO

PROPOSAL FOR RESEARCH – LOW-COST MEDICAL DIAGNOSTICS PLATFORM 16 May, 2013

The United States has a propensity to conduct operations in austere environs where power, accessibility and harsh conditions preclude the use of high-end (i.e. fragile and expensive) medical diagnostics platforms. This research aims to develop a solution to the critical need for point of care devices that are cheap, power-efficient, reliable and transportable.

Diagnostics is a challenging discipline as it usually involves prohibitively expensive and immobile equipment that regularly forces patients to travel great distances at great cost in order to access care. These inherent traits regularly exclude certain populations from receiving proper treatment. Affected populations can range from military members operating in an expeditionary theater to rural communities, especially in developing countries. The immediate impact of this research is clear: it will allow individuals to access healthcare who otherwise would not be able.

Viewing the problem from an electronic hardware standpoint it is easy to see the challenge: the given measures of merit (cost, reliability, power, and transportability) are often mutually exclusive; ex. increasing a component's transportability often decreases its reliability. Dr. Clifford's group has had incredible success pairing low-cost electronics (microcontrollers) with one of the most widely accessible hardware platforms available, a mobile phone, to develop, prototype and test effective diagnostic tools. State-of-the-art signal processing and machine learning are run on these platforms to provide ubiquitous diagnostic care. I plan on leveraging my knowledge of Field Programmable Gate Array (FPGA) technology with my background in signal processing to advance this research.

FPGAs are often used to perform highly repetitive computational tasks at very fast speeds. Concurrent signal assignments paired with the ability to instantiate hardware at the gate level create an ideal platform for increasing computational speed while allowing for high precision in optimizing the amount of necessary hardware components. FPGAs also allow for rapid prototyping of solutions, which can result in swift progression from a mere schematic to field tests. These prototypes easily map to the Register Transfer Level (RTL), eventually resulting in an Application Specific Integrated Circuit (ASIC) layout and fabrication for cost-effective production in volume.

The FPGA could be used to interface between a biomedical transducer, which converts biological phenomena to electronic signals, and a mobile phone. The mobile phone is used to perform high-level signal processing and could pass data to the FPGA in order to perform recurring computational tasks that could rapidly drain the mobile phone's battery. This will result in a low-power (system runs on a mobile phone battery), inexpensive (almost disposable) diagnostics platform that can fit in a uniform pocket. Complex signal processing and machine learning algorithms can run in real time on the systems. The implications of this research are widespread and immediate: many more people will have access to high quality healthcare.

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I would be delighted to have Ryan on my research team and I feel he is in a unique position to be an immediate contributor to the important research we are pursuing. I am confident that proper execution of the above proposal would be sufficient for the conference of a DPhil. I also believe that with the proper work ethic, this research can be accomplished within the three-year timeframe Ryan has been given.

Dr. Gari Clifford, University Lecturer in Biomedical Engineering
Director, Centre for Doctoral Training in Healthcare Innovation,
Institute of Biomedical Engineering, Department of Engineering Science
University of Oxford

2 Attachment - DF Research Office Approval to Conduct Research

3 Attachment - USAFA Judge Advocate Approval to Conduct Research