

## **STATEMENT OF GRANT PURPOSE**

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Additive Manufacturing and 3D Printing**

The aerospace industry, and more specifically rockets, are known for their precise and complex parts. To the common space enthusiast these rockets magically appear to make their journey to the stars, but their real beginning is during their design, on the production floor, and in a complex, refined, and developed manufacturing process. Computer aided design has enabled engineers around the world to create precision systems, like the rocket engines that can power the modern rockets and spaceships we see today. But these systems are not just computer files that can stand alone; they need fabrication in real life to make a difference. Design engineers have been constrained by the limitations of available manufacturing techniques. In the case of critical temperature rocket nozzles, challenges like internal features and part fixturing requirements make it extremely difficult for flight acceptance. However, additive manufacturing (AM), which is the process of building up designed parts from the computer layer by layer, offers the ability to manufacture parts otherwise impossible or extremely difficult to create outside of a computer screen. A good way to conceptualize this relatively new field is picturing yourself assembling your favorite burger. You start with the bottom bun “layer,” then the patty, the cheese, the lettuce and so on. AM is much the same. You build a part--one layer at a time. With this new process, design and manufacturing engineers can now create systems that were previously only an engineer’s dream. I am applying for a Fulbright-funded MSc in AM and 3D printing from the University of Nottingham to gain insight into the future of additive technologies in order to apply those principles in my work in commercial space.

The University of Nottingham and its Institute for Advanced Manufacturing are a leading research powerhouse in AM and 3D printing, with its research in computational methods, printing materials, and overall process control. I plan to apply the knowledge and skills I learn from this program to the aerospace industry, the current leader in utilizing AM for many flight parts. Much of my experience so far in additive processes has been working with and around a direct metal laser sintering (DMLS) printer on an internship at Rocket Lab. I helped in the production of all the Electron engine’s thrust chambers, Rocket Lab’s small satellite rocket. This thrust chamber’s nozzle, currently in nearly every modern rocket, has been redesigned to improve its performance. This improvement is made directly possible by the introduction of metal AM. Aerospace was the first industry that could bring a propulsion engineers’ complex dreams to life with the implementation of wacky internal features that could actively cool the nozzle’s wall, greatly reducing the overall mass of the engine and increasing its overall performance. The impact this process can have on industries around the world cannot be understated. A tremendous number of engineering problems that I have encountered still need to be solved. The solutions to these problems will reduce cost, increase print speed, and improve the quality of each part coming out of a 3D printing machine. I am thrilled that inquiry into the improvement in all of these processes is currently part of the active research at the University of Nottingham. I have had preliminary contact with Professor Martin Baumanns, assistant professor of AM management and Director of the AM and 3D printing master’s program at the University of Nottingham. From him I learned about the unique courses offered by the University and the specific classes within the program. Earning this Fulbright and allowing me to take part in this master’s program will hone my skills and afford me the opportunity to improve the quality and usability of additive processes. Many universities around the world who offer additive

manufacturing programs are research based, diving deep into fundamental research. Nottingham, with its post-graduate taught course, provides an opportunity for students to become more well-rounded in AM while diving deeply into a few topics that are of special interest to each student. This deeper analysis and focused study is more valuable to me than other less focused programs as I pursue my career as a future manufacturing engineer within commercial space.

The post-graduate taught course with small research projects that the University of Nottingham offers directly aligns with my interests. This program researches technology levels 1-3, the very new technologies that are so new that industry standards have yet to be developed. The program consists of block modules, normal lecture courses, and a large summer individual project that culminates our learning into a specific focus area in AM. After talking to Professor Baumann, the advanced manufacturing course that reviews the current practices in post-printing conditioning and processing seems the most intriguing to me. This is also an area in the aerospace industry that needs significant work, as I have learned from personal experience at Rocket Lab. The program also hosts smaller AM conferences and students travel to a few large conferences throughout the year to connect, learn and share knowledge I am most excited about the Germany AM conference, FormNext, which the professors and graduate students at the university attend, as I have used several German-based additive machines and enjoy the build quality and user interface.

The community outreach that is currently active at the University is plentiful and interesting, especially Code Club. Code Club is an outreach program committed to educating young students on the power and future of coding and computers. I was fortunate to go to an afterschool program during my elementary and middle school days that introduced me to STEM topics and provided me with the freedom to be creative and build what was on my mind. To this day, I still code on multiple platforms to analyze data and control machines. Providing my young mind with the resources and professional assistance I needed to be creative and to create led me to my career as an engineer. I know that there are children around the world, just like me, that just need a little inspiration to find their passion in any STEM field.

A well-rounded educational background in mechanical engineering (ME) from my undergraduate university, research in Inconel (a common 3D printed nickel-based super alloy) and hands-on additive and advanced manufacturing work as an intern at Rocket Lab and working closely with engineers from New Zealand, have equipped me to be successful in my pursuit of this specific advanced engineering degree and studying in another country. Once I discovered the commercial space industry and its connection with additive manufacturing, I was driven to enter this exciting and groundbreaking field. My passion drove me to start a rocket club, UNH Students for the Exploration and Development of Space. We are currently working on the design and manufacturing of a hybrid rocket engine and we are creating a space community that shares my excitement for the space industry and the thrilling advancements that will come in our lifetimes. The learning and experiences I will have at the University of Nottingham in this specific additive program directly align with my long-term professional goal: to have an impact on manufacturing which resonates around the world. After receiving such an excellent education through this program, I will be prepared to continue my work in the fast-paced commercial space industry, contributing to the goal of sending humans deeper into space. Acceptance into the Fulbright program will pave the way to become a more globally minded, well-rounded leader and engineer.