ARIEL CHITAN

INTERN FINAL REPORT

NIHERST/NASA INTERNATIONAL INTERNSHIP PROGRAM 2018

ACKNOWLEDGEMENTS

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A special thank-you to one of my newest and best friends, Meiliu Wu.

And thank you, of course, to my family.

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SUMMARY

I was one of the two interns chosen for the 2018 NIHERST/NASA International Internship Program conducted at the Ames Research Center in Silicon Valley, California. Prior to this internship, I was an undergraduate pursuing a double major degree in Physics and Mathematics at the University of the West Indies. In this report, I discuss the work that was undertaken while at NASA Ames – an analysis of the effect of upstream blockages on the National Full-Scale Aerodynamics Complex 80-Foot by 120-Foot Wind Tunnel. I also discuss the positive impact it has had on me both academically and personally.

INTRODUCTION

The NIHERST/NASA International Internship Program (I^2P) first started in 2012. This prestigious internship is awarded to students of Science, Technology, Engineering and Mathematics (STEM) from Trinidad and Tobago who demonstrate a keen interest in space, research and development. After a rigorous process, two students were chosen for the 2018 cycle – Mr. Keenan Chatar, and myself, Ms. Ariel Chitan (Figure 1). (NIHERST 2018)

The branch of the National Aeronautics and Space Administration (NASA), chosen for this internship is the Ames Research Center (ARC) located in Silicon Valley, California (Figure 2). This center was established in 1939 under the then named National Advisory Committee for Aeronautics (N-A-C-A). It was named after the chair of NACA, Joseph Ames. Research areas at Ames are wide and varied. Research is conducted in aeromechanics, life sciences, nanotechnology, to just name a few. (Dunbar 2008)

For this internship I was chosen to work in the Aeromechanics Branch under Dr. William Warmbrodt (Figure 3). He has been one of the most influential people to have been a part of my life – even the short time I had worked with him. His love and kindness has left a lasting impact on the way I view life.

The Aeromechanics Branch is usually full of vibrant, fun interns from all over the United States (and some international, like myself) during the summer (Figure 4). Unlike other branches at Ames, the large number of interns fosters togetherness and teamwork (and makes making friends very easy.) The Aeromechanics branch is right next to an open area where one can usually see planes and helicopters land and take off (Figure 5) which made walking to work every morning something I looked forward to.

The Branch itself focuses upon all aspects of aeromechanics. This involves everything from computational fluid dynamics (CFD), model building and testing, to research and outreach. One of my projects fell under model building, testing and data analysis while my second project focused upon writing a data report.

One of the biggest features of ARC is the massive wind tunnels that dominate the Center (Figure 6). I was extremely privileged to have been able to work inside of these wind tunnels. Both of my projects dealt directly with the aerodynamics and flow quality of the National Full-Scale Aerodynamics Complex 80-Foot by 120-Foot Wind Tunnel (80x120). This wind tunnel is operated by the U.S. Air Force.

In this report I will provide a brief outline of the work I had undertaken while at NASA as well as lessons learnt and valuable memories.

RESEARCH CONDUCTED

The project that was undertaken is considered sensitive by NASA. As such, data and a detailed analysis is omitted.

The 80x120 is an open circuit wind tunnel. This means that air is drawn in through large inlets from the outside. Any atmospheric conditions and turbulence must be accounted for during testing. Massive structures upstream of the inlet pose significant risk for affecting testing in the 80x120 test section. This is due to the open circuit design.

NASA and the Air Force found it necessary to conduct testing that simulated different types of blockages upstream of the inlet. The effects of the turbulence generated by these blockages could then be calculated by measuring the component velocities in the test section of the wind tunnel. The test section is the region of the wind tunnel in which models are placed and flow analysis conducted. It is here where external turbulence poses the greatest threat to research.

Previous research was conducted with a $1/50^{th}$ scale model of the 80x120. This was placed in the full-scale test section. Worst case scenarios were conducted where walls of varying heights were placed at varying distances upstream of the wind tunnel inlet. Using relevant probes, the turbulence could be measured in the $1/50^{th}$ scale test section at different points. This testing was done without the addition of wind – simulating running the wind tunnel during quiescent atmospheric conditions. The results pointed to turbulence levels that were not high enough to disrupt testing.

My first project involved data analysis from this previous research. A data report also had to be constructed.

The continuation of this research was my second project where the addition of wind was necessary to be tested. This would simulate running the wind tunnel during non-quiescent atmospheric conditions. That is, how would the results of conducting the same experiment with the addition of high wind speeds vary from that which was conducted with no additional wind. It is of note that the inlet to the 80x120 draws air in from over the Pacific Ocean, so this is a necessary and important factor.

For this research to be conducted, fans had to be constructed and placed inside the test section of the wind tunnel (Figure 7). This was largely because the internal fans of 80x120 was temporarily down. The structure of these fans was modelled by my teammates and a lot of time was put into building these fans. It was a step out of the ordinary for me – a physics and mathematics major more accustomed to working on a computer – however the experience was one I learnt a lot from and dearly treasure.

These fans, once constructed, were placed into the 80x120 test section (Figure 8). The walls of the wind tunnel had to be opened out and a massive crane be used to lift these fans into the test section. It was a grand moment to see such large and important structures open and creak as they moved (There was actually an alarm ringing the entire time indicating that the crane was in use) for my project.

Before the model 80x120 could even be tested, baseline testing was necessary. An analysis of the flow quality of these fans – just the fans – had to be conducted to understand the initial conditions. This required building and setting up a cart to push around a probe that measured wind velocity.

The test section had to be cleaned and tape put down as markers for the positions at which readings were to be taken of wind velocities all along the test section from the fans (Figure 9). This took a great deal of time, especially when one realizes the scale of the test section.

Once this had been completed the probe – a TSI Alnor Velometer Probe – was mounted onto a cart (Figure 10). Readings were taken at the marked positions. This required me to push the cart around while standing in front of the fans (while they were turned on!). Safety is of utmost concern at NASA – I was required to wear safety goggles as well as ear muffs. This was proven important as the initial running of this testing saw the meshing off the fans rip off while me and one of my teammates stood in front of it taking readings. Luckily it did not result in any damage to us but did set us back quite a bit as repairs then had to be done on the fans.

Once measurements were taken I began data analysis immediately. It was amazing being a part of a huge team that was very invested in the project. We would meet with Dr. Warmbrodt and Dr. Wadcock (who was a huge part of our project) and discuss the graphs that we obtained and any ideas we had about what they suggested about the flow quality. It was quite a treat and an honour sitting between Dr. Warmbrodt and Dr. Wadcock and listening to them discuss the theory behind what was going on. It made conducting the research even more fun and inspired me to do my best.

Part of being an intern at NASA ARC is taking part in poster day – a day in which all interns present what they have been working on during the summer with NASA employees (Figure 11). It was wonderful getting to work alongside such great people and share what we had been working on for the past couple of weeks. I also had the benefit of viewing the work of all of my friends who were from different branches and had very different projects from me.

INTERN'S EXPERIENCE

One of the biggest parts of this internship was staying at the NASA Lodge. I had to share a room with another intern – which was not something I was particularly looking forward to. However, my roommate, Meiliu Wu, was one of the greatest people I met at NASA (Figure 12). She and I did almost everything together. Doing menial tasks like cooking and getting groceries instead of being chores were fun and tolerable. She and I video chat every week and are hoping to vacation together sometime next year. I have made a lifelong friend thanks to this internship. And that is not just for her but for all the wonderful people I met. The connections that were made were strong and long lasting. I learnt so much from each and every one of the friends I made.

One of the greatest influences I had was from Dr. Warmbrodt. He gave so much love and warmth to my fellow interns and I. I gained a new perspective on life and the way in which I live it. Dr. Warmbrodt, a scientist at NASA, taught me that love and togetherness is something that should be celebrated regularly and not be thought of as embarrassing or unwanted. He showed that to us every Friday where he gave us lectures on the history of California and treated us to singing, dancing and tons of ice cream and all sorts of sweets. He showed us that working hard is very important but stopping regularly and just having a good time is just as.

My research was mostly alongside Dr. Wadcock, who demanded perfection – something that I have learnt a lot from. He was very strict with how he wanted things done (to a very high standard, as they should be) but he was also very witty and sarcastic which usually had us all rolling in the test section laughing. Sitting into meetings with him and Dr. Warmbrodt was one of the best parts of the job. Their banter and humour was something I thoroughly enjoyed. However, when they started discussing the intricacies of the project and asking questions it felt as if the real fun had begun.

I have learnt and grown so much from this experience – not just on an academic level but also on a personal one.

FUTURE ENDEAVORS

Since my return I have graduated from the University of the West Indies with a degree in Physics and Mathematics (Double Major) with first class honours. I was chosen to be Valedictorian for my graduation in 2018. I am currently pursuing my Master of Philosophy Degree in Physics (Astrophysics) at the University of the West Indies (UWI). This is a research based Masters program. Having just returned from conducting research at Ames I feel more prepared than before the internship, entering this degree and starting to conduct research. The methods that I have learnt and the ways in which my mentors at NASA made me look at data from many different angles has taught me valuable techniques that I will be employing in my own research.

Further to this I am also working in the Physics Department as a Laboratory Demonstrator. The very core of this job is conducting experiments and showing university students how to properly execute experiments. I often remind myself what it was like to work with Dr. Warmbrodt and try and replicate that with students so that a positive outlook on research and development be fostered in the lab.

The specifics of my project were on wind speed and wind turbulence. Working on this project for two months has lent me some knowledge on wind. One part of the data report dealt with research simulating work done by the National Renewable Energy Laboratory on windmills. Though I am no expert, I have developed more interest in the field of renewable energy and harvesting wind energy. This is something that is heavily researched in the Physics department at the UWI. I hope to one day help in such research and utilize the knowledge that I have gained in this field as seeking new sources of renewable energy is important not just in our society but in our world.

FIGURES

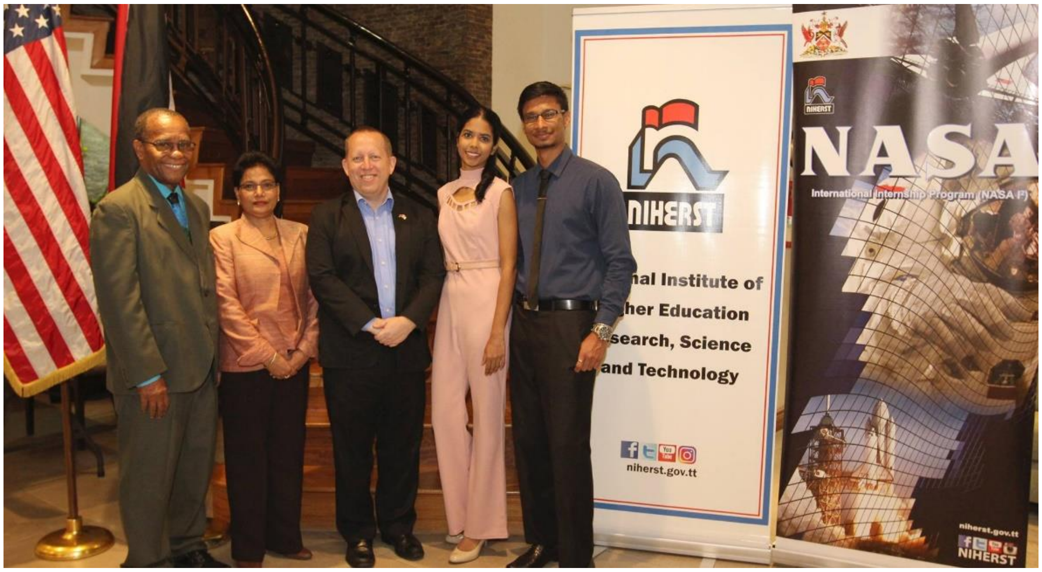

Figure 1. The NIHERST/NASA International Internship Program (Image Credit: NIHERST 2018)

Figure 2. NASA Ames Research Center (Image Credit: NASA Ames 2018)

Figure 3. Dr. William Warmbrodt

Figure 4. The Aeromechanics Interns (Image Credit: NASA ARC Aeromechanics 2018)

Figure 5. Planes Outside of the Office

Figure 6. The National Full-Scale Aerodynamics Complex 80 Foot by 120 Foot Wind Tunnel (Image Credit: NASA 2005)

Figure 7. Continuation of Previous Research Required Construction of Fans

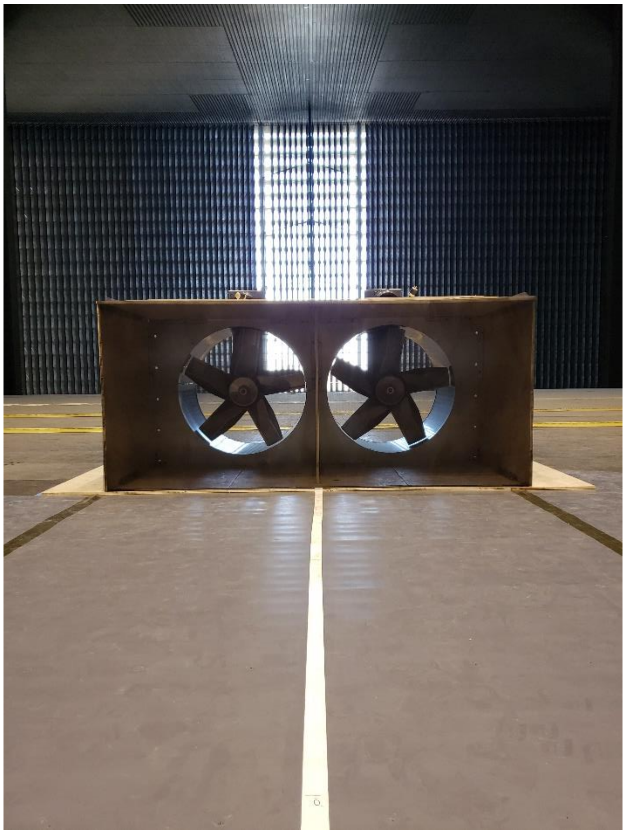

Figure 8. Fans Fully Constructed in Test Section of the 80x120

Figure 9. Lines Marked off for Baseline Testing

Figure 10. The Alnor Probe Mounted on a Cart to Conduct Flow Analysis

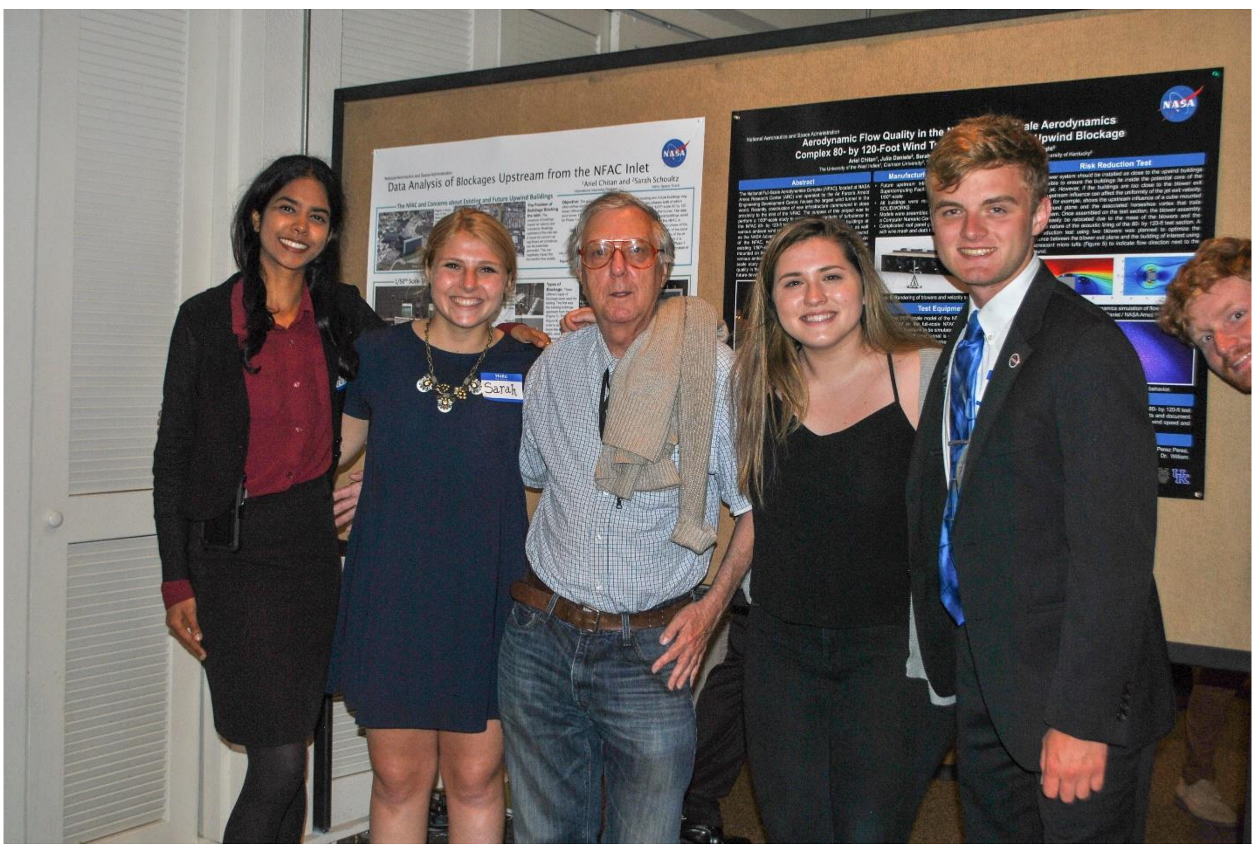

Figure 11. My Team and I at Poster Day

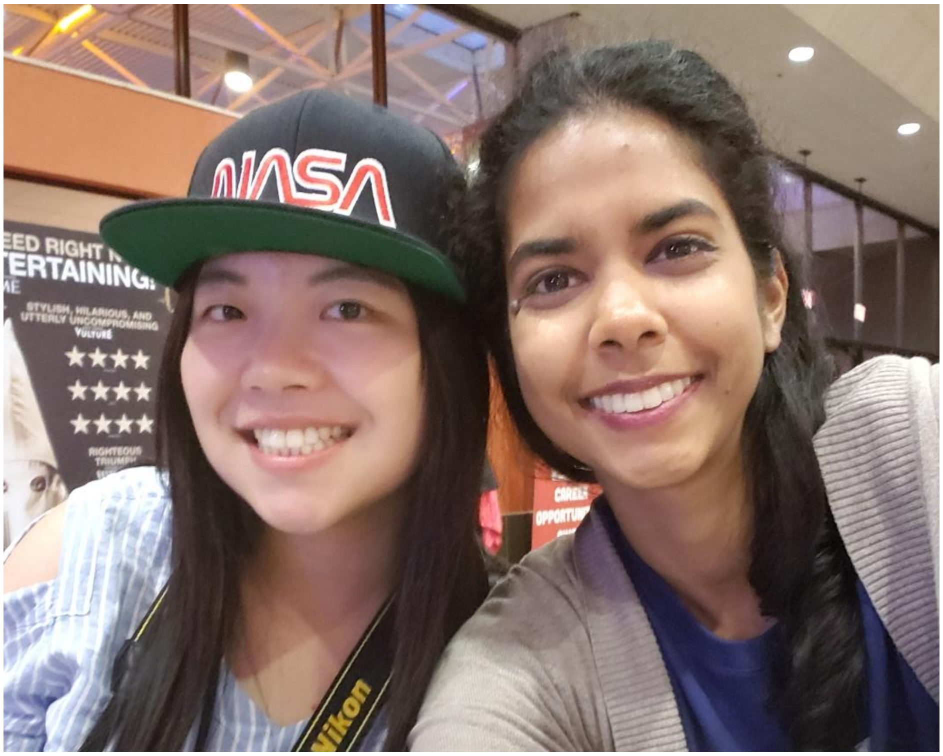

Figure 7. Meiliu and I

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