Laidlaw Scholarship Reflective Report

A reflective report is required after each summer period (by 20th September). Once submitted we will ask you to post onto the Laidlaw Network (without your supervisor comments if you wish).

This should be supplied as a Word document. Interesting photographs directly related to your research project or scholarship are encouraged and should be inserted into the body of the word document, not supplied separately.

There are six questions for you to complete. You are expected to write a detailed and thorough report; each section should be around 200-300 words.

Please note: This is NOT a technical research report. Scientific reports with a covering note cannot be accepted.

This report will need comments from your supervisor and is to be signed off by both you and your supervisor before submission.

If you have any problems or queries please contact the Laidlaw Scholarship Administrator, laidlawscholarship@leeds.ac.uk.

Scholar

Name:	Gulana Anwar
Faculty:	Engineering and Physical Sciences
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Title of Scholarship Project:	Development and Characterization of Biomimetic micropatterned surfaces

Please describe the research you have conducted this period

Biomimicry, the emulation of biological specimens for the purpose of solving complex human problems, has attracted the interest of researchers for decades. In particular, the Cicada (order Hempitera) insect wing surface portrays remarkable properties relating to self-cleaning, anti-fouling (i.e., anti-bacterial) and hydrophobicity which demonstrate superiority when compared to man-made technologies. The remarkable properties of these insects can be attributed to the wide variety of nano-features and patterning found on their cuticular surface. Currently, optimization of these pillars to enhance maximum functionality remains a challenge. To this end, the aim of this project was to characterize the nano-patterns found on the wing surface and attempt to replicate the wings of the Cicada and compare functionalities to the original wing surface.

Initially, a literature review was undertaken in order to characterize different species of Cicada insects to determine any correlations between topographical features and properties. 50 insects were studied in this manner, and relationships between diameter, height and spacing of nanopillars were determined. Following this, a replication process was set up using polymer/polymer (PDMS) replication methods. First, scanning electron microscopy was used to observe the original wing surface to compare replication results to. Following this, replication consisted of a 2-step process: original wing surface → template and then template → replica. SEM was conducted for the template and replica respectively and then certain functionalities, such as wetting, were tested using contact angle measurements. The replication proved to be successful with physical characteristics and properties similar to that of the wing surface, and improved characteristics from the original polymer surface.

How is the research work you have been undertaking impactful or important?

The presence of nano structural features on insect wings have been proven to possess key functionalities that can benefit a wide range of technologies. For example, with the rising threat of acquired antibacterial resistance to conventional chemical antibiotics, the need to develop efficient antibacterial surfaces has risen in recent years. Antimicrobial-resistant infections currently claim up to 700,000 lives each year globally, and this figure is set to rise to 10 million by 2050. One method set to overcome this issue involves actively killing bacteria as soon as they arrive on the surface of a material. The use of nano-patterned surfaces to influence bacterial cell death, using only physical interactions, shows rising importance to researchers as this could potentially target bacteria that has developed resistance to chemical antibiotics.
Moreover, the bactericidal activities of these surfaces are capable of killing pathogenic microorganisms on various appliances used daily such as, mobile phones, hospital tools, food packages, bathroom surfaces etc.
Furthermore, the anti-reflective properties of these surfaces display a growing importance in the development of optical devices. This property can be used to increase efficiency of solar cells and can also be used to reject unwanted radiations to enhance ultraviolet protection in, for example, sunglasses.
The replicated surfaces also display non-wetting (i.e., hydrophobic/waterproof) characteristics which have many technical applications. For example, super-hydrophobicity has been shown to improve heat transfer and improve the efficiency of atmospheric electrostatic energy – a source of clean, renewable energy. Manufacturing of such materials in a scalable, cost-effective manner has proven challenging.
To summarize, the applications of nano-patterned surfaces are immense, and in a rapidly evolving population, the need for improved and functional materials proves essential to all aspects of daily life.

What impact has conducting research had on your degree course and university experience?

Being able to conduct research at an undergraduate level has allowed me to broaden my horizons and has given me valuable experience for my future career path. Studying Mechanical Engineering, the career paths I have been majorly exposed to include automotives and aircraft – two areas I display lower levels of passion in. Being able to explore areas of Mechanical Engineering that are seemingly non-conventional and predominantly unheard of has strengthened my passion for the course I am studying and has allowed me to appreciate the breadth of my chosen field. Conducting research has pushed me to think more critically, and out-of-the-box, and view things from a wider perspective that is not limited by marking schemes and grade boundaries. Being able to see aspect of my degree course being applied in the research field has allowed me to appreciate the different modules of my course that, I may have deemed, less useful. Undergraduate research has provided me with many skills and experiences that simply sitting in a lecture

hall may have not provided such as, interacting with academics, exploring lab settings, understanding the link between the engineering sciences and the physical/biological sciences and academic report writing. Going into second year, I feel more confident in my ability to handle the rigorous workload than I did when I entered first year because if research has taught me anything, it is that academia is one big, exciting rollercoaster ride!

What leadership skills do you believe you have gained from the research period? (please refer to the leadership attributes below)

Conducting research over the summer has not only allowed me to personally grow, but it has also provided me with many transferrable skills that I can use towards my future leadership goals. Unlike exams and reports, the research conducted does not receive a grade and I do not need to pass-to-progress – rather, the work I do reflects my passion and drive towards the project. Thus, this has allowed me to gain energy and impact towards putting my utmost effort into the work I produce. Moreover, although I work with supervisors, I am now able to lead without authority as no one is constantly telling me what to work on, and how to do it, which has abled me to lead without authority and work and think independently. Working with a PhD student in the lab has allowed me to build a relationship and network with others working in the field and my supervisor has presented me with many opportunities which I would not have found had I not worked with these academics. My intellectual ability has become stronger, yet I also appreciate my limitations and areas of development and act accordingly to cater to these. My topic of research is an area of Engineering I am unfamiliar with and being put in a situation where I understand less has enabled me to navigate new and foreign situations. Meeting with my supervisor once a week meant that most of my time was dependent on what I put into it. Prioritising and managing my time became of immense importance as without this, procrastination would have taken up the 6 weeks. Finally, lab report writing, academic poster creating and conferences have influenced me to analyse data and interpret results efficiently and effectively and linked with improving my ability to speak and write clearly and confidently.

Please talk about activities you've been involved in to disseminate your research, including but not limited to attending conferences, producing research posters, and promotion of the scholarship

Surprisingly, the first way I disseminated my research was through my peers. Before my research, very few of my peers knew about the subject of biomimicry and thus, I explained to many peers about my research and even showed them, some of my lecturers, and my personal tutor my research. Following this, I was required to create a research poster to display on the Laidlaw scholars' network and will then upload this to LinkedIn. This will hopefully reach a targeted audience. In the upcoming weeks, I am registered to present at the International Conference of Undergraduate Research 2022 (ICUR 2022), where I will be giving a spoken presentation of 15 minutes using PowerPoint to a panel and an audience on campus. I will be placed in the "Materials and Innovative manufacturing" panel of the conference. Furthermore, my supervisor has requested me to print out a copy of my research for her to display within her lab and the results of my study have sparked the interest of the PhD student in the lab who has requested that, if fruitful, I take part in a research report write-up where my name will be mentioned. I hope to have further opportunities in the following year to present and spread my research and will be openly looking for these.

What are your future career or educational plans?

A reason I applied to the Laidlaw scholarship was due to the research aspect of the programme. I have always been interested in obtaining a PhD since many of my family members, such as my mother, are working in academia. Thus, this project allowed me to experience this area of work and view first hand if this is the right career path for me. Currently, my interests have remained strong for academia, and I do see myself obtaining a PhD in the next couple of years. An important part of obtaining a PhD is to research a subject that can benefit society, especially in underdeveloped countries like my home country: Pakistan. However, I do still wish to explore other areas of work and one area I have interest in is taking a role of leadership within an ethical business, and thus the leadership aspect of the programme was also very intriguing for me. A long-term goal of mine is to work towards opening a STEM centre/organisation for underprivileged women in Pakistan who lack access to information about different career paths. Regardless of what I choose to work in in the future, I can confidently say that I wish to work towards betterment of society, in whatever way I can.

Supervisor

Please comment on your scholar's research period, what you consider to be your scholars' strengths and which leadership attributes (please refer to the leadership attributes below) you feel your scholar has demonstrated and is particularly skilled in. You could also identify areas which your scholar can develop further.

Gulana has worked in our research group at School of Mechanical Engineering in the summer of 2022. She has taken a proactive approach from the start. In fact, she visited our laboratory to learn about our research and our approach to problem solving before choosing her Laidlaw scholarship project. She has taken over an exciting discovery-driven interdisciplinary project and showed great success with improving her knowledge by reading and understanding the available literature, reporting her own scientific observations, and planning for her next steps as the project progressed. During her Laidlaw scholarship project, Gulana has closely worked and collaborated with a previous Laidlaw scholar who is currently a PhD student in my group. Considering the short, limited duration of the project, Gulana has succeeded to identify urgent gaps in the knowledge and practical developments and drive the project accordingly. I believe that Gulana has achieved a lot during in terms of managings and conducting a research project which was a new field to her.

Signature of Scholar  Date: 20/09/2022

Signature of Project Leader  Date: 19/09/2022

Leadership Attributes

Areas that the scholar has demonstrated special skills in

Learns continually
Seeks out and fosters innovation and creativity
Turns ideas into action
Works collaboratively and across boundaries
Knows own limitations and acts accordingly
Able to listen with understanding
Has energy and impact
Makes things happen
Able to analyse data and interpret results
Able to work and think independently
Speaks and writes clearly and confidently
Uses digital connectivity
Prioritises activities and manages own time
Honestly assess own knowledge/leadership style/preferences
Uses this to build relationships and networks

areas which your scholar can develop further

Able to lead without authority
Able to convey purpose and build coalitions
Cultural intelligence and capacity for empathy
Makes effective decisions in complex environments
Strong intellectual ability
Builds relationships and networks
Uses emotional intelligence to achieve this
Capitalises on the power of diversity
Able to navigate new and foreign situations