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# Portfolio

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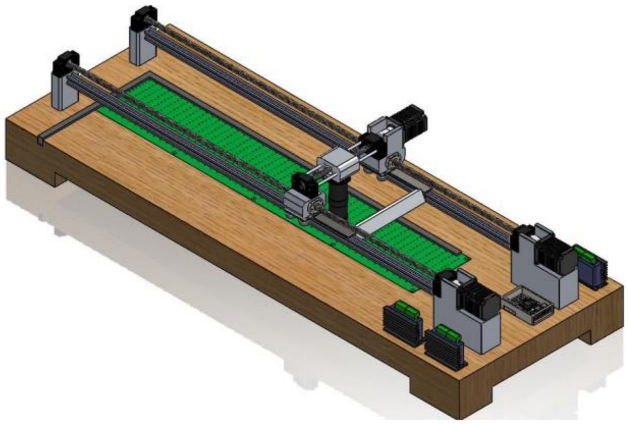
Content:

**Master's Year Final Project**

# Veneer Assessment System

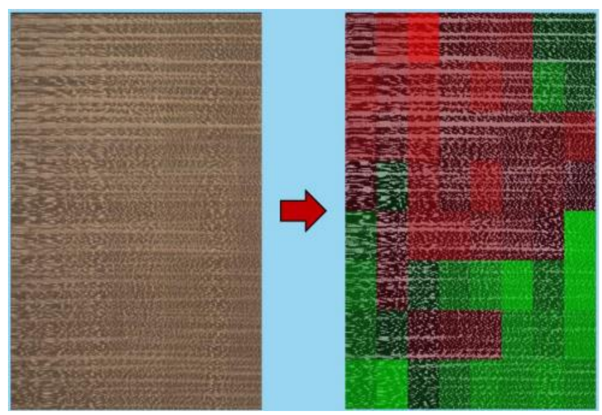
**Oct. 2023 – Jun. 2024**

Keywords: CAD (SolidWorks), Feature Identification, Coding (Python, C++), FEA, Microscopy, Digital Image Correlation (DIC)



## Summary

This project aims to create a "data-driven method in assessing the stress concentration of wood veneer pieces, which are likely to fail under forming process", as specified by our major stakeholders, a luxury automotive company. Figure above shows the final design proposal (left) and the prototype (right), that are capable in achieve all requirements set. The wood veneer is placed on the green surface, which is a vacuum system that condemn the veneer. The high resolution, microscopic camera then performs an automated scan throughout the veneer, searching for concerning features. The camera is translated around the dimension via a ball-screw, stepper, and v-slot bar setup, which provides sufficient movement's resolution. The scanned result is then process by a single board computer, which utilized feature identification algorithm to the processed (PCA, Binarizations) image. The final assessment result of the algorithm is then fed into the system frontend, to demonstrate the end-user and advise their further forming process of the piece (figure on the right).



## Innovation & Sustainability

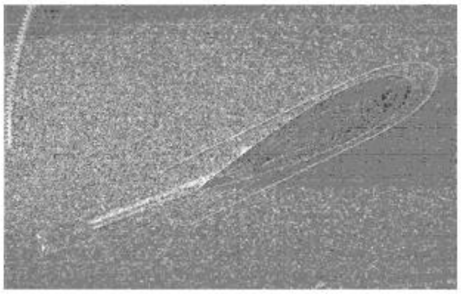
- The vacuum system designed to condemn the veneer is relatively portable when compared to literature works, as it only demands 3 conventional case fans to provide the pressure difference in the chamber.
- The combination of ball-screw, support and linearized by the v-slot are designed and manufactured specifically for this project.
- The feature identification code that is developed to fulfil the objectives, are fully original, and proved to be accurate when combined with a binarization process.
- Most part of the final design proposal's hardware made by recyclable materials.
- The success of this project suggests that wood veneer, can be considered more to be implemented in not only car interior, but also furniture, flooring, wallpaper etc, this will reduce the use of non-recyclable materials in decorative objects, contributing towards the sustainability for the world.

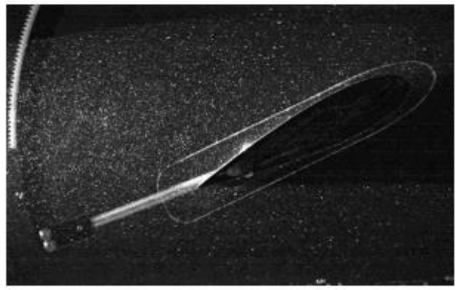
**Master's Year Experimental and Research Project**

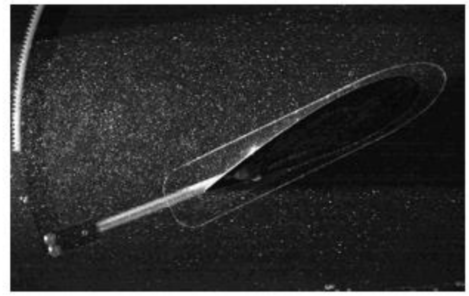
# Detailed Aerodynamic Characterisation of a NACA0020 Wing with Gurney Flap

**Feb. 2024 – Jun. 2024**

Keywords: Hot Wire Anemometry (HWA), Particle Image Velocimetry (PIV), Wind Tunnel, MATLAB, Aerodynamic, Power Spectrum Density (PSD).

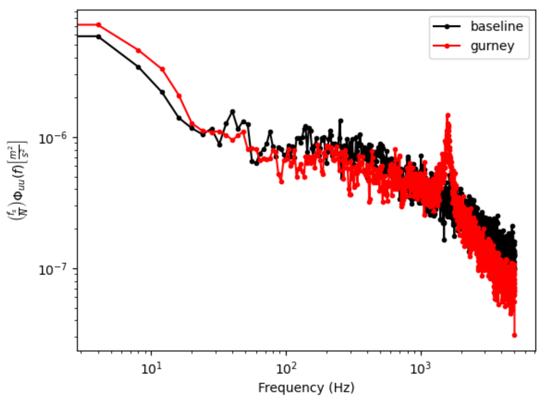


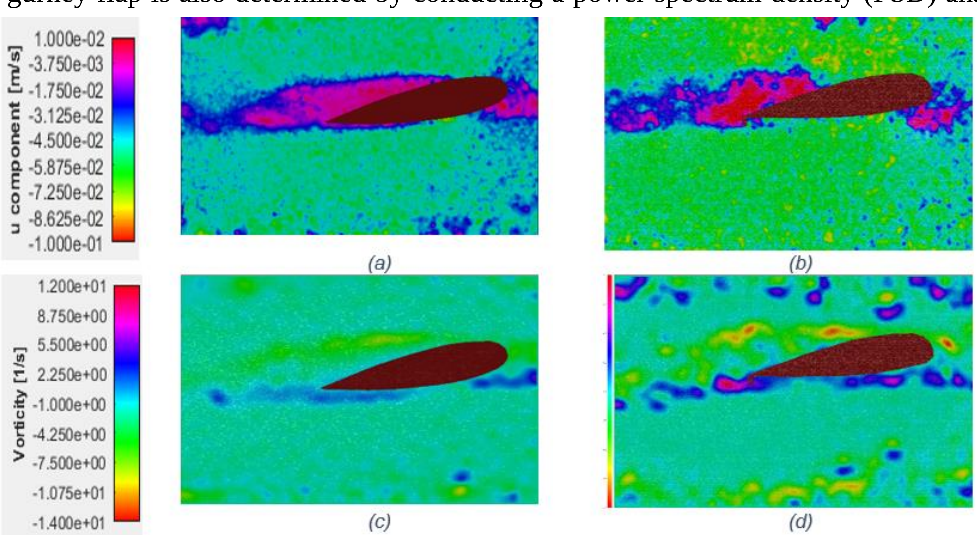




## Summary

This project primary aims to analyse the aerodynamic characteristic of a NACA0020 airfoil profile with and without integration of a gurney flap. The techniques engaged in this project includes HWA, PIV and pitot pressure probes method conducting in/using Modular Air Flow Bench AF-10, Rolling Hills Research Corporation Model 0710 Desktop Water Tunnel, and RJ Mitchell Wind Tunnel Respectively. As a few methods is implemented in this project, the secondary aim will be to investigate the pros and cons of each method. The data processing of the HWA is mainly conducted using python language, for greater efficiency when calculating large and complex data. The main tools used for image processing for the PIV is a MATLAB application, PIVLab, proven to be consistent, while providing an easy interacting front-end. Lastly for the pitot-pressure based method, Microsoft Excel is used instead. The main conclusion of the experiments all agreed that the turbulent intensity in the wake increases while the velocity profile down wake has its magnitude slightly decreased when implemented a gurney flap. The frequency of vortex shedding when implemented a gurney flap is also determined by conducting a power spectrum density (PSD) analysis to the HWA result and concluded to be 1580Hz (figure on the right). By comparing the results of each experimental methods, it is summarized that HWA provides the highest frequency response and spatial resolution. Although the PIV doesn't achieve as high resolution as the HWA, the image-based method provides interesting insights to the flow characteristic visually. The pitot-pressure based measurements on the wake region gives the poorest resolution and faces extreme challenges to provide correct results during high turbulent intensity environment.



(a) (b) (c) (d)

**MEng Third Year Final Project**

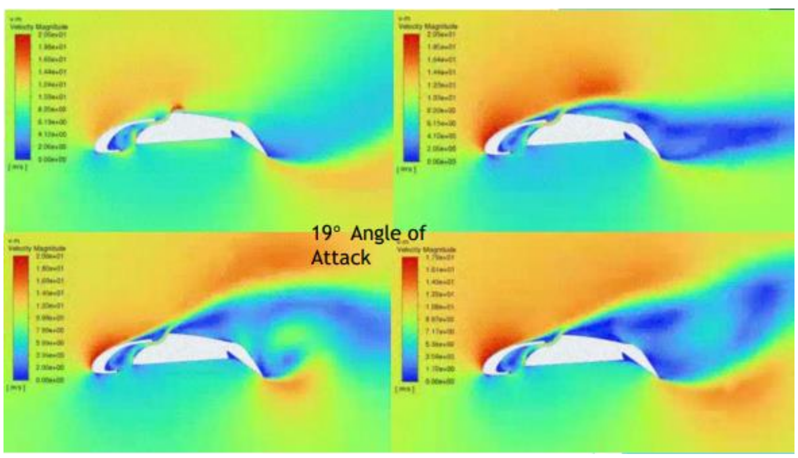
# Design, Manufacturing and Testing of High Lift Devices

**Oct. 2022 – Jun. 2023**

Keywords: CAD (SolidWorks), Aerodynamic, CFD (Ansys Fluent, Xflr5), Mesh (Fidelity Pointwise, Harpoon), Wind Tunnel Testing



## Summary




This project aims to investigate the real-world effect of a high-lift devices on a Clark-Y airfoil, which are widely used in general purpose aircraft design. The early phase consists of heavy literature review to design the key mechanism that deploys the high-lift devices. The final decision for the deployment of the leading edge-slat is the four-bar linkage and a simple hinge for the trailing edge flap. The mechanism is then manufactured using the CNC, waterjet cutting machine as well as some hands on for detailing. The main section of the wing is constructed using foam cutter on polystyrene blocks. The assembled wing is then tested for different deployment state of the high-lift devices in the RJ Mitchell Wind Tunnel, and the complex force report is calculated and post-processed using Microsoft Excel. The experimental results are then compared to the CFD results (figure on the right) with identical Reynolds number of approximately 260000.

## Challenges

- The nature of a Clark-Y airfoil of thin body section introduced extra challenging process when designing the leading-edge slat mechanism as it is difficult and costly to fit in powerful yet compact electronics devices. Hence the final decision is to utilized mechanical mechanism that don't require motors to be functioning.
- The CFD of a wing with relative complex geometry results in inaccurate report using steady-state simulation. A transient approach is taken to tackle this problem with a more intense model of k-ω SST, to capture more turbulence condition of the case.
- To reduce the experiment uncertainty, the force report of every angle of attack in each state of deployment of the high-lift device is recorded with an interval of 1 second in a total of 30 second period. This result in a large amount of raw data that needs to process into readable and convertible data, combination of Python and Microsoft Excel is implemented to address this issue.

**Second Year Design Project**

# Design, Manufacturing and Testing of a UAV

**Oct. 2021 – Jun. 2022**

Keywords: CAD (SolidWorks, Autodesk Tinker), Electronics, FEA (Ansys), Field Testing, Teamwork, Project Plan

## Summary

This project mainly focusses on designing and manufacturing a UAV/drone that are capable to operate and perform surveillance task through a 2-axis gimbal camera system attached on it. To maintain steady level flight and achieve quick response on the control, a flight controller and receiver is needed hence mounted together. A weight estimation is carried out to help determining the amount of lift force needed thus the final choice of the motor and the number of blades on the propeller can be decided. The self-levelling gimbal is achieved by introducing 2 servo motor, one for the rotation of each axis, and designing a connector to fit them all together, and with the camera. Additional requirement of it being able to withstand a 1 metre height free-fall while maintaining its structural integrity is achieved by repeating the process of research and development as well as investing great amount of time in conducting FEA to the landing gear. The final prototype is shown as figure on the right.