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Words from the editor

I hope that you enjoy this newsletter. In this issue, you will read about research currently being done in the department, an update on a former department member, and some pictures of the department throughout history. If you have any comments or recommendations for future articles, please do not hesitate to contact the editor at editor@cordite.ca. Thank you.

Improving Tilt Wing Transition with Leading Edge Tubercles

by 2Lt Felix Sim

Tilt wing aircraft are capable hovering like rotorcraft while maintaining the favourable forward flight performance of conventional fixed wing aircraft. They achieve this by tilting wing mounted propellers and the wing itself to a vertical position for vertical takeoff and landing (VTOL) mode, and a horizontal position for regular forward flight mode. Compared to tilt rotor aircraft, like the V-22 Osprey, tilt wing aircraft have an aerodynamic advantage as the blown wing augments the performance of the wing at high angles of attack. High angle of attack performance can be further improved with the addition of tubercles. Tubercles are bio-inspired passive flow control devices inspired by the flippers of humpback whales[1]. They have been shown to delay stall and improve post stall performance of aerodynamic surfaces by generating counter rotating streamwise vortices that promote flow attachment[1, 2, 3, 4, 5, 6]. Figure 1 shows a planform view of a wing section with tubercles.

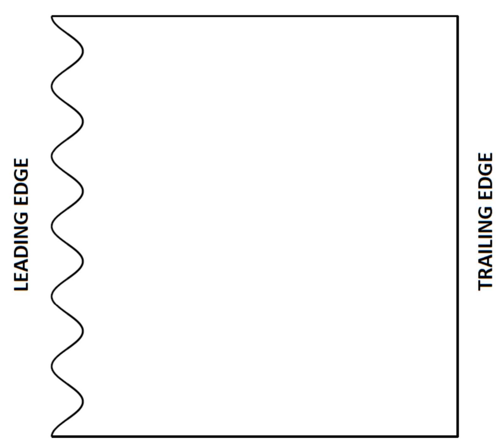

Figure 1: Planform view of a wing section with leading edge tubercles.

By placing tubercles in the propeller slipstream, they have the potential to further enhance the high angle of attack performance of a blown wing, which is a critical factor in determining the performance of a tilt wing aircraft during transition between VTOL and forward flight modes. To investigate this potential, initial wind tunnel testing was conducted at the RMC wind tunnel. The experimental test rig consisted of a wing section mounted on a circular disc in the slipstream of a propeller. The angle of attack of the wing was set by rotating the circular disc to the desired angle. Wing forces were measured using an *ATI mini85* load cell. Figure 2 shows the experimental rig.

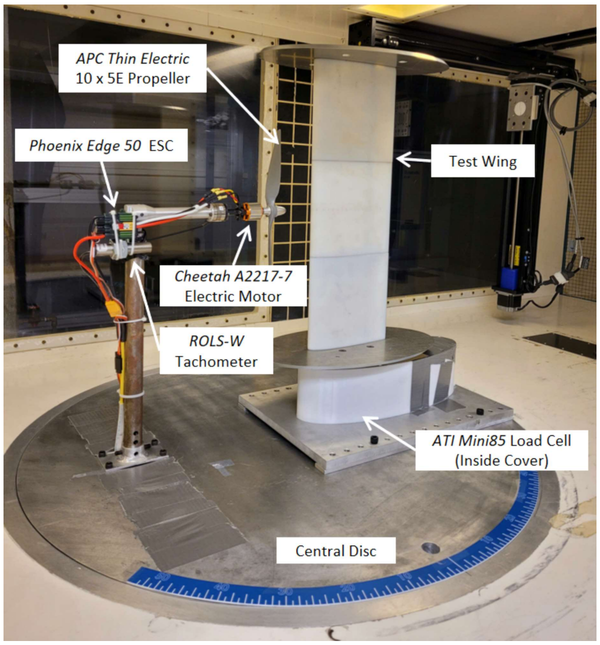

Figure 2: Experimental rig for the initial wind tunnel campaign.

Wing aerodynamic data was collected for different tubercle shapes and different propeller positions relative to the leading edge of the wing. Using the results of the best performing propeller position, the transition performance of a theoretical tilt wing unmanned aerial vehicle (UAV) was determined. The transition performance was quantified using what is known as a transition corridor. The transition corridor shows the flyable speeds for each wing tilt angle between 0 and 90 degrees. This often results in a narrow band showing the flight envelope of the tilt wing aircraft during transition. Figure 3 shows the transition corridor for each of the different tubercles tested. The dotted lines are an extrapolated estimate of the tubercle effects for angles that were not tested in the wind tunnel. All of the tubercles tested expand the lower bound of the transition corridor increasing the flight envelope of tilt wing vehicles during transition, ultimately allowing for safer operation during this critical phase of flight.

The promising results of this initial wind tunnel campaign will be further explored with the design and flight testing of a 3D printed UAV. A more detailed overview of the wind tunnel campaign and extended results can be found in Sim *et al.* (2022).

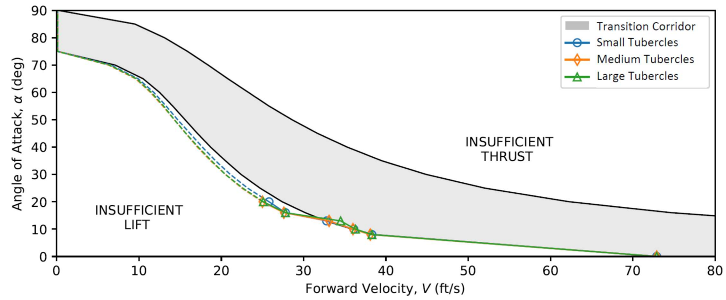

Figure 3: Improvements to the transition corridor of a theoretical tilt wing vehicle[7].

References

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[2] Sudhakar, S., Karthikeyan, N., and Venkatakrishnan, L., "Influence of Leading Edge Tubercles on Aerodynamic Characteristics of a High Aspect-Ratio UAV," *Aerospace Science and Technology*, Vol. 69, October 2017, pp. 281–289.

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[5] Hansen, K., Kelso, R., and Dally, B., "Performance Variations of Leading-Edge Tubercles for Distinct Airfoil Profiles," *AIAA Journal*, Vol. 49, 2011, pp. 185–194.

[6] Bolzon, M., Kelso, R., and Arjomandi, M., "Tubercles and Their Applications," *Journal of Aerospace Engineering*, Vol. 29, 2015, pp. 1–10.

[7] Sim, F., Colpitts, R., Perez, R. E., and Asghar, A., "Effect of Leading Edge Tubercles on Tilt-Wing Transition," *AIAA AVIATION Forum*, 2022.

Where are they now?

by Z. Marshall

As students graduate and leave the department, previously inseparable friends may, after a few years after graduation, find that they've lost contact with each other.

In response to this, the Cordite Foundation has decided to add a feature in our newsletter called "Where are they now?", where we track down department alumni and catch up with their professional and personal life.

For this first installment, we caught up with Maj(ret'd) Paul Bordush (I know, spoilers!). For those who don't know Paul, he was part of the first Aerospace engineering class, back in 2009, the only class to have graduated with the promise of their programme getting accredited. However, their faith was rewarded when the programme received accreditation the following year. Following graduation, Paul went to the first part of his AERE training in CFB Borden. In September, he took off to wonderful CFB Cold Lake to finalize the on-site experience portion of his training. He was so good that, after finishing the second part of his AERE training in Borden, he got posted back to Cold Lake as the OpMO (now known as the Aircraft Servicing Officer) at 410 Squadron. After just a year in that position, he moved to 1 Air Maintenance Squadron for another year before getting selected to do a master's degree in propulsion in at Cranfield University in the UK. Once he completed his degree in 2014, he moved to Ottawa where he oversaw the technical management of both the F404 and T56 engines. After being in this position until 2018, Paul decided to return to academia at RMC and become a lecturer with the Department. It was during this posting that Capt Paul Bordush was promoted to Major. However, his knowledge and expertise were in such high demand that he was called upon to retire from the CAF and join the public service as an engine subject matter expert with DTAES. After only a year and a half, he was once again plucked from his position, promoted, and placed in charge of the entire engines management team, the same team he was part off after finishing his master's degree.

During his time at RMC, Paul also signed on to be the secretary for the Cordite Foundation, a position he occupied for two years before passing it on but staying on with the Foundation as a member without portfolio, allowing him to tackle more complex projects, like creating the Foundation website. During our chat, Paul outlined how much he enjoys the technical and engineering work he gets to do in the RCAF. He especially noted the important technical work the department provides to the RCAF, recollecting a trip he was able to take to Moose Jaw back in January 2020 for engine testing, to assist with building an engine model. He was even able to bring an OCdt along, which Paul believes underlines the importance of having Military Faculty in the Department. Military Faculty give students an occasion to see and hear about the CAF outside of RMC and get them prepared for their future careers as officers in the CAF.

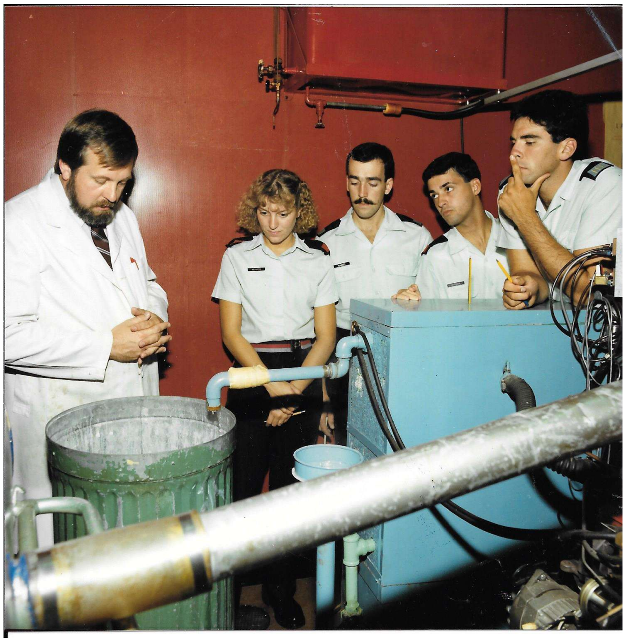
In terms of personal achievements, Paul has his fair share. He got married in 2013 while in England for his studies and since then, has had three wonderful children, who are 4, 6, and 7-years old. For those wondering where he is now, Paul currently lives and works in Ottawa, but starting January 2023, can be found once a week in Kingston at RMC teaching the propulsion class to the 4th year students.

A snapshot in time

by M. Bardon

The following images were taken during various departmental activities throughout the years. Have a look and see if you recognize anyone in the pictures.

The game being played is called "Carrier Landings". The object of the game is to land the aircraft on the deck of the aircraft carrier (shown in white at the front of the photo with the landing deck marked). A cord is attached to the post seen on the carrier deck and extends to the player, who has a handle on the other end of the string at his end. When the plane is released by the player standing on the table , it slides down the cord towards the carrier. By tightening or loosening the cord and raising or lowering it at his end, the “pilot” adjusts both aircraft speed and altitude. The bystanders assist the pilot by providing unsolicited advice, cheers and hoots of derision.



This 3rd year Franco class is getting instructions from the professor for running the spark ignition engine test in their thermo course. At that time, the SI engine being used was a 1972 Chevrolet 6 cylinder in- line engine. The blue box seen in the photo contains the radiator of the engine. The box is well insulated so as to avoid any significant heat loss from the radiator. The cooling water simply passes through the radiator and into the garbage can. Knowing the mass and temperature of water collected over a timed interval allows the energy lost by the engine to its cooling water to be determined. Here the attention of both students and prof seems to be unusually focused on the garbage can. That is likely because the instructor is pointing out that, despite its humble appearance, the collection of water over a long enough interval provides a high degree of accuracy for the heat loss calculation – better in fact than would be obtained with an electronic flow meter.

This is the 2003 class taking the 4th year elective course, Marine Systems Engineering. The photo was taken during their visit to the Marine Museum of the Great Lakes in Kingston. As well as the museum itself, the class also toured the former Canadian Coast Guard icebreaker Alexander Henry, seen in the photo afloat in the historic dry-dock at the museum.