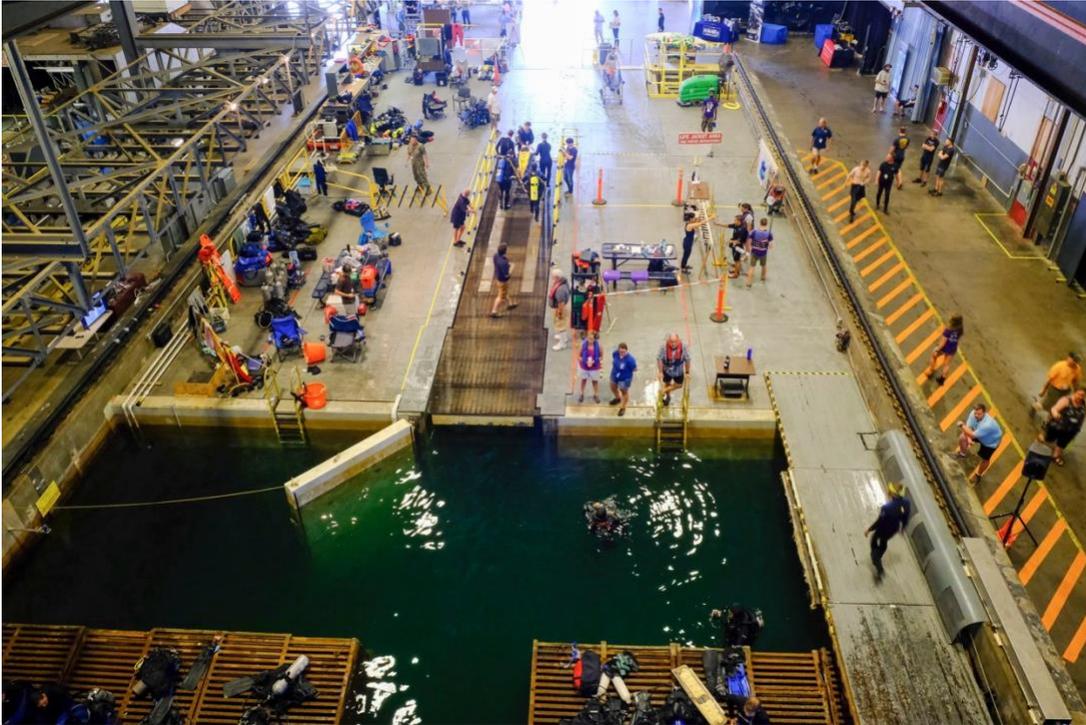


# University of Victoria - Chinook II Submarine Racing Club 2019 ISR 15 Competition Summary



*Team Members: Jaryd Middleton, Garrett Reid, Ethan Glenwright, Liam Scott-Moncrieff,  
Spencer Funk, Tobin Huffman, Sophie Sacilotto, Ben Markwick*

## *The Competition*



This year the UVic Submarine Racing Team (UVSRC) attended the 15<sup>th</sup> International Submarine Races (ISR 15) at the Carderock Naval Warfare Centre in Washington D.C., building on experiences from 2018 at the European International Submarine Races (eISR 2018) in Gosport, England. This marked the club's second successful venture on the international stage and our first time at the International Submarine Races.

The International Submarine Race's 100 meter "drag race" style course contrasts its European counterpart which primarily tests maneuverability with slalom and circuit components. The two international competitions alternate annually and challenge teams to continually adapt their submarines for optimal performance in both venues.

## *The Design*



Last year at the European International Submarine Races, our team learned a lot about how to improve our submarine! Going into 2019, that gave us a good direction to work in when optimizing the submarine for this year's competition.

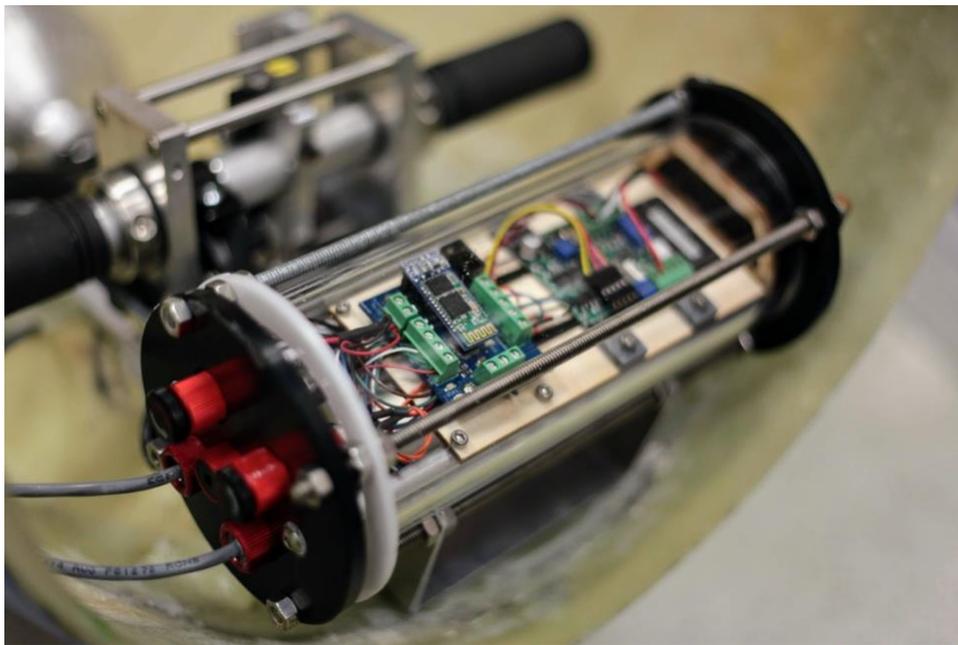
One of the challenges we faced last year was the lack of concrete parameters; we did not know how much power the pilot would be able to output, what cadence they should pedal at, how we would make sure the submarine was balanced, what kind of speed we would be able to achieve and a lot more. Together, these variables made it difficult to determine the size of our control surfaces for steering, whether certain elements would be useful like the nozzle we had around our blades and more.

We surpassed our expectation at eISR despite the whole team having very little manufacturing experience or knowledge of human powered submarines. Chinook took the prize for Most Reliable Submarine - despite having very little time to test in the water as all the systems being designed and constructed simultaneously. We are especially proud of that award because reliability is very important in engineering and we were only in our first year as a club! The context and experience we gained last year along with our focus on reliability helped steer the design decisions this year and guided us as we came into ISR 15.

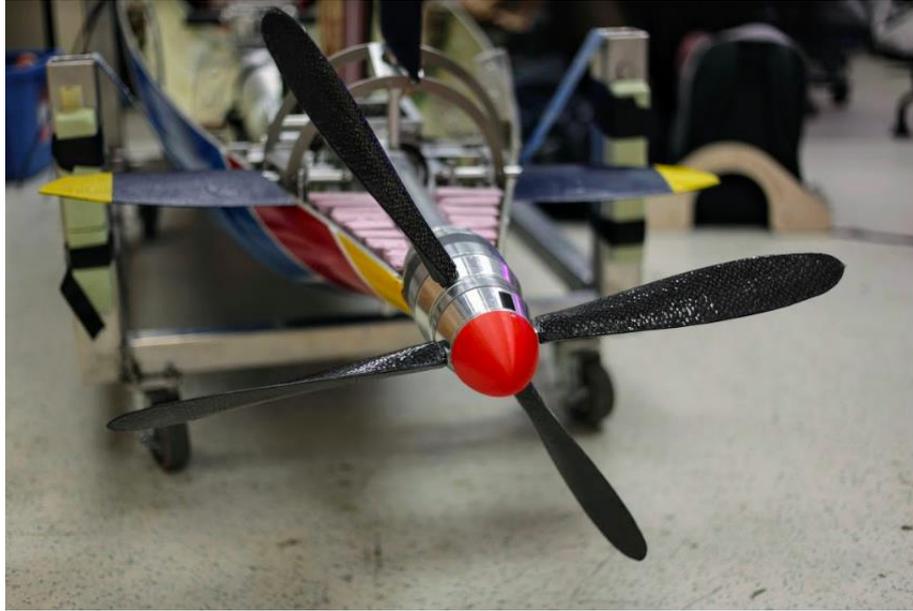
Since the International Submarine Races focus primarily on speed, we broke down the physics behind the event and focused our upgrades around a few basic principles. As a club we worked largely on increasing power from the pilot, minimizing our drag, and increasing the overall efficiency of the submarine.

To improve the power, we created a new system dedicated to improving the pilot's bio-mechanics and spoke with an expert for some guidance. In order to increase the power output of the pilot, clip-in pedals were added and the crank length on the propulsion system was maximized. A shoulder restraint system was also added to give the pilot something solid to locate themselves on, similar to a bike seat.

Our biggest addition to the submarine was an electrical control system. This system would autonomously regulate the depth of the submarine using software and electronics designed by our team and were kept dry in two custom waterproof housings. This would allow the pilot to put more energy into being a human engine and less on keeping the submarine at optimal depth. Due to the risky nature of using electronics underwater, we developed this electrical control system in parallel with a mechanical backup that can be switched underwater.



In order to minimize drag, we first looked at our control surfaces and nozzle which were quite large. Using finite element analysis to simulate the effect of water on the submarine we found that the nozzle around our blades was creating as much drag at top speed as our entire hull. As a result, we abandoned the nozzle system which then required us to completely re-design the steering system. Following this learning we developed a steering system that was modular allowing us to experiment with several sizes of control surfaces to achieve the exact amount of steering and diving ability needed.



Finally, we worked on efficiency. Starting at the back of the submarine, we re-designed our propeller hubs to accommodate four blades instead of six. This allowed more space between the blades meaning the leading edge of the secondary blade would cut through less of the turbulence from the blade before it. With fewer blades they need to be larger and stronger as more power is being transferred from the submarine to the water per blade. This was achieved by making last years' 3D printed method more rigid with a combination of 3D printed plastic, machined aluminum rods and carbon fiber. In addition to changing the blade structure and arrangement, a large amount of research was put into making the control surfaces more powerful for their size. This was done with the integration of tubercles, found on humpback whale fins, into the control surface design. This allowed the dive planes and rudders to be made even smaller.

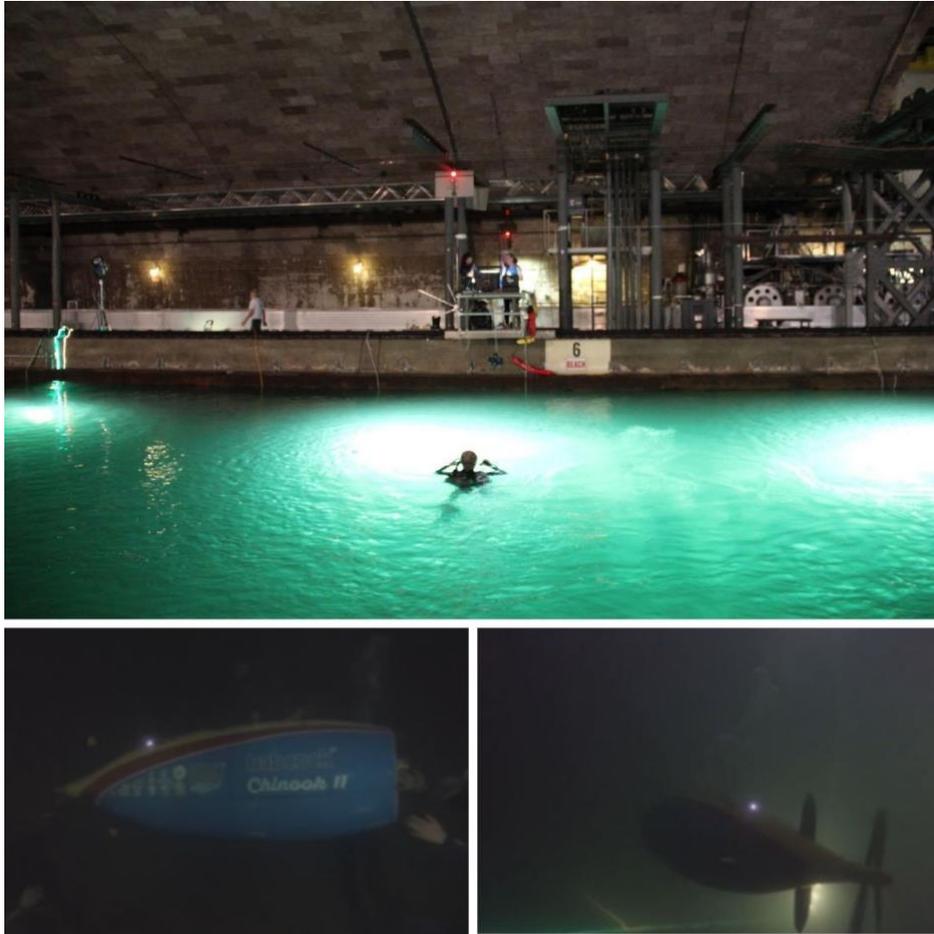


## *Performance Summary*

Starting June 21<sup>st</sup>, eight members of the UVic Submarine Racing Club traveled down to Washington D.C. to finally race our updated submarine – Chinook II. Arriving in Washington D.C. June 22<sup>nd</sup> and at the Carderock Naval Warfare Centre on June 23<sup>rd</sup> our team got to work quickly assembling our submarine which had traveled to Maryland in four parts with the University of British Columbia team. We passed our dry inspection on June 23<sup>rd</sup> and our wet inspections June 24<sup>th</sup>, clearing the integrity of the design and reliability of all our safety features for us to start racing.



Before our first race, our dive team calibrated the submarine and loaded the pilot to rehearse our safety protocol a final time. Ensuring the submarine was well calibrated was essential to ensure depth control and stability allowing for a good first run. This was achieved easily thanks to some well-rehearsed underwater signals allowing the divers to communicate. Once in the que and signaled to get ready to race, our diver confirmed the team was ready and our pilot set off for his first race of the year!



The submarine quickly accelerated down the course and out of the view of the divers. She completed a full run with a speed of 2.94 knots – a fabulous start to the competition.

Throughout the five days of the competition that followed we had eight more runs of the course. Three of these runs, including the first one, were successful with our top speed in a completed race reaching 3.84 knots. Over the course of these nine runs we had the chance to rotate pilots with our primary pilot Jaryd Middleton in the submarine for six runs and our Dive Master Garrett Reid and divers Tobin Huffman and Ben Markwick each taking turns running their first courses at the international level.

Chinook II ran into some technical issues throughout the competition. The first arose during our third run of the competition when the screw attaching the top rudder to a rod slipped and the submarine was forced into the right wall. This collision caused some damage to our dome but luckily none to the pilot and we managed the repair the dents easily.



More collisions occurred with the left wall near the end of the competition as our pilots reached higher speeds. These collisions were found to be caused by the majority of the submarine's drag being concentrated in the front half of the hull. Following the removal of the nozzle, this centre of drag was now the strongest and would force the submarine left as soon as the pilot neared 4 knots.



Two of the biggest sources of pride and worry for the team going into the competition were the electronics system and the new steering system. The electronics system was incredibly successful functioning perfectly and the enclosure within which it was kept stayed mostly dry throughout the competition, even lasting through a night underwater! The steering system was also a success (aside from the slip of the top rudder) and did well maintaining the line of the submarine.

By the end of the competition on June 28<sup>th</sup>, Chinook II and the UVic Submarine Racing Club placed 5<sup>th</sup> with a time of 3.84 knots. Additionally, our electrical system, four-part hull design and tubercles (on the dive planes) were acknowledged with the Best Use of Technology award. This was a big source of pride for our team, especially Liam Scott-Moncrieff and Ethan Glenwright who lead the team in the design and manufacturing of the electronics and tubercles!

In conclusion, this competition was not only fun and rewarding but a great learning experience! We are honoured to have been one of the five teams to represent Canada at the 15<sup>th</sup> International Submarine Races and one of the two Canadian teams to have placed in the top five. A huge congratulations to Omer 12 achieving the fastest speed of the competition!

The 15<sup>th</sup> International Submarine Races were another step in seeing the real-world applications of those skills our team has learned in their schooling and have redoubled the team's passion for marine engineering.



## *Thank you*



The University of Victoria Submarine Racing Club would like to thank all those who have supported them over this past year in their endeavours!

We would like to thank Babcock for their generous support! You have inspired our members and showed so many of us how the marine engineering skills we are learning through competitions such as the International Submarine Races are applicable in our futures.

We would like to thank SSI for their support and for providing our members with the chance to learn about software use in the marine engineering industry for their future professional careers.

We would like to thank Rainhouse for the support they provided us in the manufacturing of our new steering system and for hosting such the Rainhouse event on June 22<sup>nd</sup>!

We would like to thank the University of Victoria and all of the amazing staff in their Engineering and Science departments for their generous support throughout the development of our club! We would especially like to thank Mary-Anne Teo, Jennifer Holmes, Julia Keenan, Rodney Katz, Chris Secord and our faculty advisor Dr. Curran Crawford.

We would like to thank SKF bearings for their support!

We would like to thank Composites Canada for their support!

We would like to thank the Submarine Club of the University of British Columbia for getting our team started two year ago and being an amazing support at our first International Submarine Competition!

## *Next Year*

As we now turn our attention towards the next year and the 2020 European International Submarine Races, we already have a few ideas of how we can improve up our design and make the next year, the clubs third, its best yet! Our goals include expanding the club's membership, growing our network of sponsors, finding a more expansive pool in which to test the submarine, and providing group training opportunities for both our pilots and dive team.

We look forward to this next year and cannot wait report more improvements, advancements and successes next year!

You can follow our progress throughout the year at the links below!

Instagram: @uvicsubmarine (<https://www.instagram.com/uvicsubmarine/>)

Facebook: <https://www.facebook.com/uvicsubmarine/>

Website: <https://www.uvicsubmarine.com/>

See you next year!

