

2019 Special Edition

WAVES



**15th International
Submarine Races at
Carderock Division**



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Capt. Cedric McNeal
Commanding Officer

Larry Tarasek, SES
Technical Director

Roxie Merritt
Corporate Communications Director

Contributors:

Nicholas Brezzell, Katie Ellis-Warfield, Harry Friedman, Ryan Hanyok, Edvin Hernandez, Neubar Kamalian, Devin Pisner, Brooke Marquardt, Monica McCoy, Benjamin McKnight III, Kelley Stirling, Kevin Sykes, Lydia Weyrich and Margaret Zavarelli

ISR 15 Winners

The Booz Allen Hamilton Overall Performance Award

Winner: OMER 11/École de Technologie Supérieure
Runner-up: WASUB IX/Delft University of Technology

Innovation Award

Winner: OMER 11/École de Technologie Supérieure
First Honorable Mention: UMPTYsquatch 9 / Sussex County, NJ Technical School
Second Honorable Mention: TRIDENT/Virginia Tech

The American Systems Best Use of Technology Award

Winner: CHINOOK II/University of Victoria

Absolute Speed Award

Winner: OMER 11/École de Technologie Supérieure - 6.85 knots

Best Design Outline

Winner: WASUB IX/Delft University of Technology

Smooth Operator Award

Winner: GODIVA III MOD I/University of Warwick

Best Spirit of the Races

Winners (tie): MARYLAND MAKO / KIDS and OMER 11/École de Technologie Supérieure

Fastest Speed by Category

One Person, Non-Propeller, College

Winner: OMER 11/École de Technologie Supérieure - 4.78 knots

One Person, Propeller, Independent

Winner: MARYLAND MAKO/Kids Into Discovering Science (KIDS) - 2.34 knots

One Person, Propeller, High School

Winner: CLS MAKO/Frederick County Career & Technology Center - 3.29 knots
Runner-up: CORMORANT/Dover Area High School - 0.92 knots

One Person, Propeller, College

Winner: OMER 11/École de Technologie Supérieure - 6.85 knots
Runner-up: WASUB IX/Delft University of Technology - 6.54 knot

2019 FURE Scholarship Winner

An award of \$2000 was made to Mr. Andrew Prater who graduated from Crawford Mosley High School and is a member of the Gulf Coast State College submarine team.

Submarine races sail into Carderock once again

By NSWCCD Public Affairs

In most competitions, teams have an opportunity to train for the final event. For the International Human-Powered Submarine Races (ISR), that doesn't happen until the actual races held at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland.

"Where else are you going to find a 100-meter underwater race course in a world-class facility to test the speed of your submarine with the support of the Navy Experimental Dive Unit (NEDU)?" asked Charles Behrle, a retired Navy captain and president of the Foundation for Underwater Research and Education (FURE), which sponsored the 15th ISR June 24-28. "At best, they can test their submarine in a swimming pool for buoyancy and maybe a little movement."

Carderock hosted the event in its 3,200-foot David Taylor Model Basin where 19 academic teams brought 21 submarines to race. This biennial science, technology, engineering and math (STEM) event provides an avenue for high school and college teams to tackle the difficult challenges of submarine design, construction and operation. The students have to design, build and race a one- or two-person, human-powered submersible on an underwater course.

"We hosted over 20 teams from across the nation and also from the Netherlands, Canada and Great Britain," said Capt. Cedric McNeal, Carderock's commanding officer. "Those teams are not only showing off their innovation

and their technological capabilities toward supporting racing, but also building platforms that will contribute to what we see as planting seeds for the next generation of the workforce."

One of the students from Texas A&M even scored a job interview while he was at Carderock for ISR. Whether he gets the job remains to be seen, but in the meantime, he and his teammates were working hard to get their two-person submarine, 12th Manatee, down the course.

"Our biggest goal is finishing a race and progressing to see how fast we can get it from there," said Peter Blank, a returning participant to the competition. Unfortunately, it was not to be this year.

Most of the submarines have bicycle-styled gearing for propulsion and a student who is SCUBA certified inside the submarine, which is full of water. Contestants dive the submarine and pedal their way down the course. The submarine stays underwater for the 100-meter course as they race for speed, which is captured in the middle 10 meters.

"Being human-powered makes it an equalizer, as well as an increased complexity of requiring a human-machine interface," said Behrle, who is also a former commander of Carderock. "We want to ensure that we are challenging their minds, regardless of the amount of resources they may have."

Besides the strength of the person propelling the submarine forward, the key to success is the design of the boat. Being mostly engineering students, this challenge was primarily hindered by budgets. For some teams, like L'Ecole de Technologie Supérieure from Montreal, Quebec, the budget was well-resourced. They even brought their own machine shop to make repairs throughout the week on their submarine Omer 11.

For others, especially the high school teams, the students relied on their ingenuity. Dover Area High School of Dover, Pennsylvania, entered ISR for the first time. They've been in several other engineering-centered contests, like Punkin' Chunkin' and Battle of the Rockets, but this offered a bigger challenge. Their submarine, the Cormorant, is made up of four layers of fiberglass and riveted together with aluminum bands. The drive train was

created almost completely of repurposed bicycle parts: the gears, gearshift, the pedals and the rear-sprocket.

"We tried to keep it as simple as possible," said Jakub Becker, a recently graduated team member and a pilot for the submarine. "Our biggest success has been that we haven't had any big mechanical issues, our failure to race has mostly been pilot error, myself."

Behrle explained that even when a submarine doesn't make it down the course, it's not really a failure.

"The students learn from every run, and this event gives them the opportunity to really flex their brains to find ways to make course corrections as necessary," Behrle said.

When teams do have mechanical problems, they have not only been coordinating with opposing teams to make repairs, but they've also enlisted the help of one of Carderock's own, Patrick McGrail, a mechanical technician in the Towing Basin Operations Branch. Using mill and lathe machines, McGrail helped the University of Michigan with a broken crankshaft and recycled the leftover material to make a separate part for the University of Waterloo. While he said it is not necessarily part of his assigned duties, he wants to see the teams succeed.

"You want to help wherever you can," McGrail said. "It's in the spirit of things."

A couple local teams, such as Kids Into Discovering Science (KIDS) and Frederick County Career and Technology, received special attention from Maryland's top office. Lt. Gov. Boyd Rutherford paid a visit, allowing them to tell him about their experience at ISR and show off their submarines.

"I had a wonderful time at the International Submarine Races this morning," Rutherford posted on his Facebook page after his visit. "This biennial design competition provides young men and women with the opportunity to design, build and race human-powered underwater vehicles, and requires an impressive amount of STEM knowledge and skill. Congratulations to all the young men and women who participated in today's event." KIDS is an educational organization from Accokeek, Maryland,

DAVID MODEL



that focuses on K-12 students.

Liam Vincent first got involved with the team 10 years ago when he saw the group testing a submarine in a local swimming pool. He is going to be a junior in high school in the fall and is a project manager for the KIDS team.

“It’s my job to make sure that everybody is involved, that everyone has a role and that we’re targeting their interests,” he said.

For Carderock, one of the goals is to recruit students for STEM jobs.

The STEM and Outreach Program Director for Carderock, Charlotte George, asked other employees to sit at a recruiting table at the event. George herself was a contestant when she attended Florida Atlantic University.

“ISR was a life-changing experience for me that exposed me to other Department of Defense opportunities,” George said. “This event gives us a large pool of potential employees, and we hope to snag some of them. It’s our ‘gateway’ event.”

Ashlee Floyd, a non-destructive testing

engineer in Carderock’s Welding, Processing and Non-destructive Evaluation Branch, spends a good amount of time recruiting for Carderock and worked at ISR talking to students.

“If you don’t recruit, how can you get the best talent?” Floyd asked.

With so many student divers at Carderock for ISR, safety is a big deal. Carderock’s two dive officers were in the David Taylor Model Basin the whole week supporting the efforts of NEDU and the Naval Academy Dive Locker,

TAYLOR BASIN

Teams gather for the final day of the 15th International Human-Powered Submarine Races, hosted at Naval Surface Warfare Center, Carderock Division in the 3,200-foot David Taylor Model Basin in West Bethesda, Md., June 24-28, 2019. (U.S. Navy photo by Nicholas Brezzell/Released)



as well as civilian volunteer divers.

“One of the primary missions we have here is ensuring the contestants are safe in the water, as well as retrieving contestants, whether it’s along the water column or at the end near the finish line,” said Marc Nelson, one of Carderock’s command dive officers. “All the students have been doing a great job, they’ve been really comfortable in the water, and that’s definitely a confidence booster for all of us.”

In the end, the team from Quebec with their submarine, Omer 11, was the big winner, taking the highest speed for a one-person, propeller submarine away from the Netherlands’ Wasub IV on the last day of competition. The two teams had been tied at 6.4 knots going into the final day, but Omer 11 sped into the lead at 6.85 knots, compared with Wasub IV’s 6.54 knots. Omer 11 also took the Innovation Award, the Best Spirit of the Races Award and the Overall Performance Award.

Editor’s Note: Kelley Stirling, Edwin

Hernandez, Brooke Marquardt, Benjamin McKnight III and Lydia Weyrich contributed to this story.



Eric Ritter, Naval History and Heritage Command (NHHC) a public relations outreach specialist, stands with NHHC naval history displays at the International Human-Powered Submarine Races (ISR) on June 25, 2019, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Lydia Weyrich/Released)

History and future on display at Carderock during sub races

By Lydia Weyrich,
NSWCCD Public Affairs

The 15th International Human Submarine Races (ISR), held at Naval Surface Warfare Center, Carderock Division, has welcomed teams from all over the world, and here to remind them “where the fleet began” is the Naval History and Heritage Command (NHHC).

Featured at NHHC’s table were posters and displays all detailing the history of the Navy, as well as a 3D printed model of a future submarine, which was created by Carderock’s Curator of Ship Models with the help of the Model Fabrication Shop.

Eric Ritter, a public relations outreach specialist at NHHC, said the command’s objective is to show the ISR participants

how far the Navy has come and where it is headed.

“The NHHC is a group of collaborative minds scientifically informing engineering marvels that will be today’s Navy, as well as future Navy,” Ritter said. The NHHC handed out various pieces of literature showcasing important pieces of naval history, and they encouraged their visitors to utilize the vast realm of historical information at their disposal courtesy of the command.

Carderock technician lends a hand during the submarine races

By Lydia Weyrich,
NSWCCD Public Affairs

Teams have packed up their years' worth of hard work and traveled to West Bethesda, Maryland, to race submarines they designed and built themselves in Carderock Division's 3,200-foot long David Taylor Model Basin for the 15th International Human-Powered Submarine Races (ISR).

The event was held June 24-28, 2019, in West Bethesda, Maryland. Over 20 college and high school teams were welcomed on base from around the world and across the United States.

Each submarine on display was creatively designed, but some of the vessels experienced troubles on their time trial runs.

Patrick McGrail, a technician in the Towing Basin Operations (Mechanical) Branch at Carderock, helped several teams throughout the week with their mechanical problems by fixing and creating parts through the use of mill and lathe machines. McGrail said it isn't necessarily part of his assigned duties to assist, but he said he wants to see the teams succeed.



Patrick McGrail, a technician in the Towing Basin Operations (Mechanical) Branch of Naval Surface Warfare Center, Carderock Division, constructs a submarine part out of recycled metal material for the University of Waterloo's one-person propeller submarine, Claire, on June 26, 2019, during the 15th International Human-Powered Submarine Races in West Bethesda, Md. (U.S. Navy photo by Edwin Hernandez/Released)

"You want to help wherever you can," McGrail said. "It's in the spirit of things."

On June 26, McGrail helped the University of Michigan with a broken crankshaft, and recycled the leftover material to make a separate part for the University of Waterloo. He said the demand for help from his shop varies, but his goal is to get the teams back in the water as soon as possible.

When McGrail is not helping with ISR, he spends his days fixing mechanical issues throughout all sectors of the basin. His work ranges from creating

machine parts, operating rig tests and fitting models, to maintaining the general integrity of the basin itself.

With his years of experience, McGrail embraces new challenges, especially if it benefits young and aspiring engineers.



Maryland lieutenant governor visits the submarine races at Carderock

By Kelley Stirling,
NSWCCD Public Affairs

Maryland Lt. Gov. Boyd Rutherford spent a good amount of time talking to students from the Maryland area during his visit to the 15th International Human-Powered Submarine Races in West Bethesda, Maryland, on June 26. Although he has been to Naval Surface Warfare Center, Carderock Division before, this was his first time seeing the international science, technology, engineering and math (STEM) event.

Students from both Frederick County Career and Technology Center, a high school in Frederick, Maryland, and Kids into Discovering Science, an educational organization from Accokeek, Maryland, talked extensively with Rutherford about their submarines and what it took to make them.

While at Carderock, Rutherford observed the races and visited with the men and women that make the event happen. Capt. Cedric McNeal, Carderock's commanding officer, and Charlie Behrle, president of the Foundation for Underwater Research and Education, gave the lieutenant governor a tour of the David Taylor Model Basin where the races were taking place and introduced him to the 21 teams from across the country and around the world.

Photos from Rutherford's visit are posted on his Facebook Page: <https://www.facebook.com/BoydKRutherford/>.

More photos of Rutherford, as well as photos and videos from ISR overall can be found on Carderock's Facebook Page: <https://www.facebook.com/CarderockDivision/>.

Maryland Lt. Gov. Boyd Rutherford (second from right) tours David Taylor Model Basin on June 26, 2019, in West Bethesda, Md., with Naval Surface Warfare Center, Carderock Division Commanding Officer Capt. Cedric McNeal (center), International Submarine Races (ISR) lead Charles Behrle (left) and STEM Director Charlotte George (right). During his visit, Boyd met with ISR teams from Maryland and other schools. Carderock Division co-hosted the 15th ISR in its 3,200-foot David Taylor Model Basin in West Bethesda, Md., June 24-28. (U.S. Navy photo by Monica McCoy/Released)

All the way from Montclair, New Jersey, Tyler Nedzi has found herself spending the summer as not only a Naval Research Enterprise Internship Program (NREIP) intern at Naval Surface Warfare Center, Carderock Division (NSWCCD), but also as the University of Michigan International Human-Powered Submarine Races (ISR) team captain.

When Nedzi toured the University of Michigan before beginning her freshman year, she had no idea it would have such an impact on her future.

During her visit, the tour guide took Nedzi through the building that housed the project teams, which featured the University of Michigan human-powered submarine project. As an avid scuba diver, seeing a project with such a large diving aspect intrigued Nedzi.

“I saw that it was a scuba-diving project and I was like ‘Oh that’s really cool,’ but then I even found my major through this project—naval architecture—I didn’t know it existed,” Nedzi said.

From then on, Nedzi knew what she wanted her major to be, and what she wanted to spend the next four years of her life pursuing. Nedzi joined the team her freshman year and has participated every year since.

Under the mentorship of Rachel Jacobs, a chemical engineer in Carderock’s Wastewater Management Branch, Nedzi has spent two summers as an NREIP intern at Carderock while simultaneously being involved in the Foundation for Underwater Research and Education’s ISR.

The sub races are held at Carderock’s 3,200-foot David Taylor Model Basin in West Bethesda, Maryland, biennial. In 2018 Nedzi traveled to Gosport, England, to participate in the competition. She said Jacobs has been very understanding and supportive of her commitment to ISR both years and is excited to see the team in action this year with Nedzi as their captain.

During her internships at Carderock, Nedzi said she has bettered her engineering skills, and also enhanced her leadership skills through the guidance of Jacobs.

When Nedzi ran into problems with her team last year, Jacobs offered advice that Nedzi said was extremely helpful.

Tyler Nedzi: Michigan ISR team captain and Carderock intern

By Lydia Weyrich,
NSWCCD Public Affairs



Tyler Nedzi, a Naval Research Enterprise Internship Program (NREIP) intern and International Submarine Race (ISR) captain from the University of Michigan, treads water in her scuba gear as she waits for her team’s submarine, “Bluefin,” to begin its final journey down the David Taylor Model Basin on June 28, 2019, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (Navy Photo by Lydia Weyrich/Released)

As a rising senior, Nedzi is spending her last ISR before graduation as the captain for the largest team in University of Michigan history. Jumping from 15 members to 35 in one year, Nedzi said leading a team of this size had its challenges, but has taught her a lot along the way.

“There’s a lot of voices, but it’s a really eye-opening experience getting to learn from all these other people,” Nedzi said.

Due to her early involvement as a freshman, Nedzi said her promotion to captain came as a natural progression, but that it had different challenges and stresses than the role of team member.

“There’s more pressure because I’m in charge this time—last time I was just helping out,” she said, “This one’s my baby, I have to get it in order.”

During the preparation of their submarine, “Bluefin,” the team decided to pay special attention to the correlation between the construction and how their pilot pedaled. The team had problems in the past with their ship not being compatible with their pilot’s movements. To avoid similar issues this year, they measured “every joint” in the pilot’s body and built their ship to the size of their pilot.

Due to problematic past races, Nedzi said her biggest concern for ISR was making it past the finish line. On the first day, her fears were relieved when her team not only crossed, but had the best time in the college propeller category that day.

On the second day, June 25, the team participated in three more timed trials and had one successful run. They were unable to cross the finish line in their first two attempts because the pilot was traveling too fast to properly steer the submarine, but Nedzi said too much speed isn’t a problem she minded having.

“Bluefin” ultimately placed fourth in their overall category, with a top qualifying speed of 3.9 knots.

Through her unique experience as captain and NREIP intern, Nedzi said her best advice to people in her position is to invest in the younger members of the team and raise up a group of people with compatible mindsets and goals, making job assignments easier.

Now that Nedzi has concluded her last ISR as an undergrad and enters her senior year, she intends to apply to work at Carderock, but will likely start graduate school post-graduation.



Rear Adm. Ver Hage visits the submarine races

Cmdr. Bradley Hickey (right), the head of the Medical Department at Navy Experimental Dive Unit, talks with Rear Adm. Eric Ver Hage (center), commander of Naval Sea Systems Command Warfare Centers, and Capt. Cedric McNeal (third from right), commanding officer of Naval Surface Warfare Center, Carderock Division, about how his team keeps contestants safe during the 15th International Human-Powered Submarine Races on June 26, 2019. The races take place in Carderock's 3,200-foot David Taylor Model Basin in West Bethesda, Md. (U.S. Navy photo by Ryan Hanyok, Released)





Clara Hellersund, a junior at Virginia Tech, stands with her dad, David Heller, a mechanical engineer in the Facilities Engineering Branch at Naval Surface Warfare Center, Carderock, on June 24, 2019, after she finishes a submarine race during the 15th International Human-Powered Submarine Races in West Bethesda, Md. Hellersund is a support diver for the school's submarine race team. (U.S. Navy photo by Kelley Stirling/Released



Carderock engineer's daughter races for Virginia Tech

By Kelley Stirling,
NSWCCD Public Affairs

Dads sometimes leave work a little early to go watch their children compete in a race, but in David Heller's case, the race came to him. His daughter, Clara Hellersund, is a support diver for the Virginia Tech team, which has two submarines entered in the International Human-Powered Submarine Races held at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland.

Heller is a mechanical engineer in Carderock's Facilities Engineering Branch and stopped by the tow basin to watch his daughter's submarine make it to the finish line on June 24, day one of the biennial races at Carderock.

"I think it's great she's on the team," Heller said. "I'm so proud of her."

Hellersund is no stranger to Carderock. She interned with the Center for Innovation in Ship Design in 2017 between graduating from George C. Marshall High School in Falls Church, Virginia, and starting at Virginia Tech. That's also when she first saw the submarine races.

"I saw the races and I was like, 'Oh, I want to do that,'" Hellersund said.

Initially, Hellersund planned to be an ocean engineer, but she recently changed her major to industrial and systems engineering. She said while her parents did not outwardly encourage engineering, it was always part of their life.

"Engineering was something I was always aware of because Dad was in engineering," Hellersund said, adding that ultimately, though, she herself chose engineering.

As an intern at Carderock, Hellersund participated in an additive manufacturing challenge, where students were tasked that could filter water waste from garbage patches in the water. Her team's boat was called the Pacific Area Cleanup-Manned Vessel, or PAC-Man. This experience solidified Hellersund's path to engineering.

After she graduates from college, Hellersund plans to work in industry as an industrial and systems engineer, though she doesn't know where yet.



High schoolers compete in all things engineering, including submarine races

By Brooke Marquardt, NSWCCD Public Affairs



Members of the Dover Area High School team from Pennsylvania (from left) Caleb Helbert, Tyler Sengia, Braden Hilbert, Jakub Becker and Skyler Sinclair gather around their submarine, the Cormorant, at the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md., on June 25, 2019. (U.S. Navy photo by Brooke Marquardt/Released)

This Dover Area High School team of engineer wannabes has competed in events like Punkin' Chunkin', a pumpkin-throwing contest, and Battle of the Rockets, but this is their first time at the International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland. Dover Area High School is in Dover, Pennsylvania, just under three hours away from the basin.

When they realized they wanted to enter the races, they had just under a year to register and build a submarine. All of the team members are now recently graduated, with the exception of one. A few of them boasted about how their interest is not particularly in submarines,

but in any competition where they can show off their love for engineering.

Their submarine, the Cormorant, is made of four layers of fiberglass and riveted together with aluminum bands. The drive train was created almost completely of repurposed bicycle parts. This team used the gears, gearshift, the pedals and the rear-sprocket.

“We tried to keep it as simple as possible,” said Jakub Becker, a recently graduated team member and a pilot for the team. “Our biggest success has been that we haven’t had any big mechanical issues, our failure to race has mostly been pilot error, myself.”

“One of the things that many teams

have been impressed with was that we made the propeller ourselves. We were able to mill out ours at our high school rather than outsourcing it,” said team member Caleb Hilbert. “Meeting other teams and being around other people so passionate about engineering has been the best part for us. We’ve been able to solve some of our problems by seeing how other teams solved theirs.”

Florida Atlantic brings veteran guidance to ISR

By Benjamin McKnight III,
NSWCCD Public Affairs

When the very first International Human-powered Submarine Races were held in West Palm Beach, Florida, in 1989, Tony Lavigne was there. 30 years later, Lavigne is once again at the ISR, guiding the Florida Atlantic University (FAU) team in their participation at Naval Surface Warfare Center, Carderock Division.

FAU is a long way away from Boca Raton, Florida, race week but they are not in uncharted territory, having competed in multiple ISRs since its inception. With them is the Atlantic II, designed and built completely by the FAU Human-Powered Submarine Club.

The first iteration of Atlantic was highly successful as the fastest submarine in the one-person college category of the 2017 races, and second in absolute speed among all competing submarines. Even with that accomplishment, team member Declan DePietro said they could go faster.

“We were hitting a speed and weren’t getting past that,” he said. “So for this submarine we spent a lot of time doing design, engineering and testing for the hull specifically.”

Part of that design adjustment included modifying the steering system, which teammate Ryan Fisher said had an



Declan DePietro works on the hull of Atlantic II on June 27, 2019, as teammates look on during the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Benjamin McKnight III/Released)

articulating tail for greater mobility in Atlantic I. The team decided for Atlantic II to use standard rudders and dive planks, improving its straight-line speed.

“This is our first time where our prop and hull match the best. Usually, the hull has a certain drag and speed, but the prop doesn’t match it,” Lavigne said. “This time, it’s all been engineered much better.”

Keeping the submarine-building processes organic was a high priority for the Owls, although time and availability was occasionally a team enemy. Outsourcing work or buying from a vendor may have been more convenient at times, but also ran the risk of sacrificing design elements for FAU.

“If we had a part that didn’t fit, we made another part that does, rather than having to get sent to us or adapt our design to an off-the-shelf piece,” Fisher said. Despite varying schedules among the team often limited them to weekend

testing of their submarine, FAU did not suffer from lack of water tests as the school is minutes from the Atlantic Ocean.

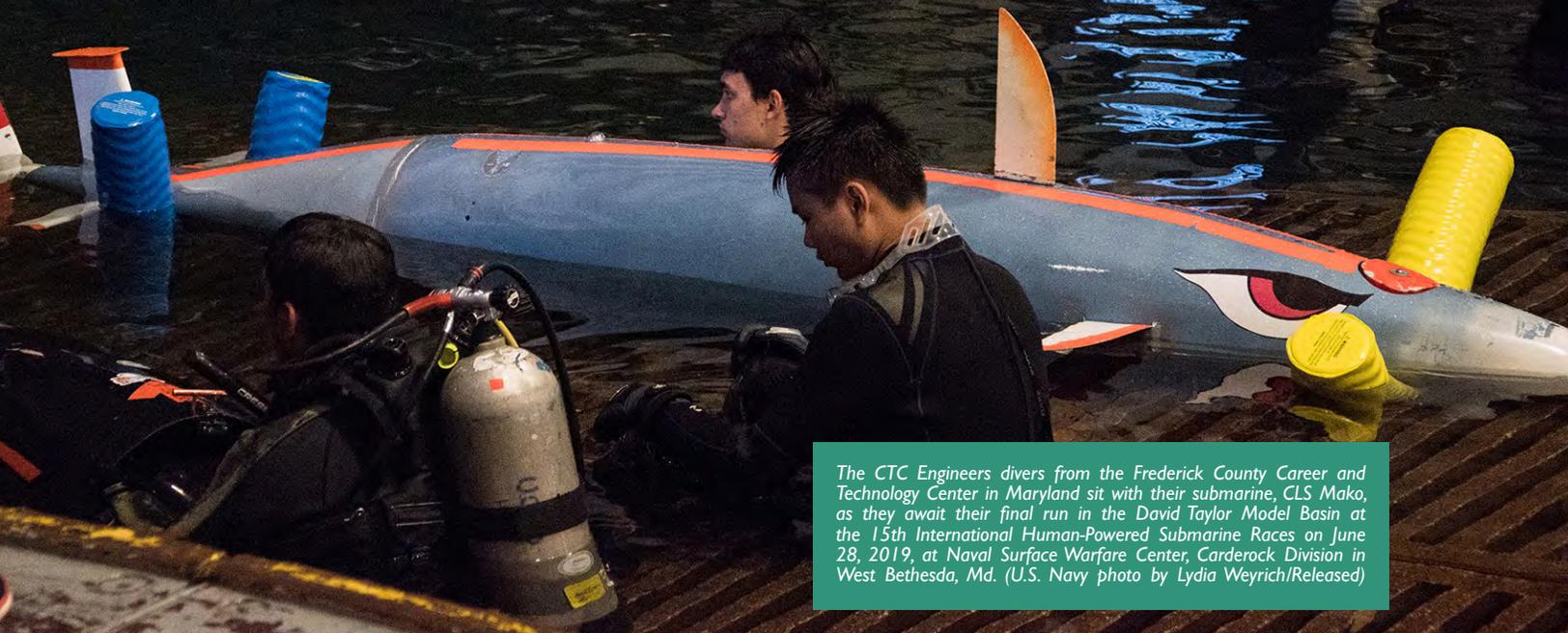
Having built a reputation for speed in recent years, the Owls returned to Carderock with great expectations. With each day, DePietro said that the objective was to go a little faster on each run so the sub could handle the eventual top speed.

“These students are going to remember this the rest of their lives. This only happens once every two years and students come to this awesome facility at most twice,” Lavigne said. “The eyes of the ocean engineering world are on us right now. Letting them have that experience is pretty cool, and you make connections for a lifetime at this place.”



Local high school wins high-category speed first time at ISR

By Lydia Weyrich, NSWCCD Public Affairs



The CTC Engineers divers from the Frederick County Career and Technology Center in Maryland sit with their submarine, CLS Mako, as they await their final run in the David Taylor Model Basin at the 15th International Human-Powered Submarine Races on June 28, 2019, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Lydia Weyrich/Released)

While the Foundation for Underwater Research and Education's (FURE) International Human-Powered Submarine Races' (ISR) participants tend to be college-heavy, three high school teams not only made the cut, but proved to be challenging competitors.

The CTC Engineers team from the Frederick County Career and Technology Center (FCCTC) in Maryland embarked on their first journey to the 15th ISR during the week of June 24-28 and ended up ranking as the top high school team throughout the competition.

Held in the Navy's longest towing basin at Naval Surface Warfare Center, Carderock Division, in West Bethesda, Maryland, ISR can prove to be taxing for even the most experienced club teams. The CTC Engineers came with modest expectations for their first go at an ISR, but when they were still maintaining their spot as the fastest high school team the morning of the final day, they began to gain confidence.

The 20-member team spent eight months of the last year modifying and adding to a hull that was donated to FCCTC by Hernando County Public

Schools in Florida. Every member, including their teacher and advisor, Philip Arnold, spent two hours each school day and six hours each Sunday working on their submarine, CLS Mako, in preparation for the competition.

"A lot of Sundays we would come back dusty and tired, but it was all worth it in the end," said Jerry Huang, the CTC Engineers' pilot.

The team started the races with a more complex two-propeller system, but during the first two days of the races the gears started binding. The complications caused unwanted friction, forcing the team to modify their ship to operate with one propeller.

"We had issues with the contra-rotating propellers, so we simplified it to a single prop, and we are doing well," Huang said on the final day of the races.

After the switch to the one-propeller system, the submarine experienced far less friction and worked on its first run post-fix.

Having never competed in an ISR before, Huang said the team

is proud of how far they came. "The fact that we could make it here as a high school team for our first year and get 12 runs by yesterday—some college teams haven't even been able to run—I think we are really proud of that."

Huang said the team learned a lot about what designs look good in theory versus what works in the water, and he hopes to apply that newfound knowledge to future projects.

"We are learning what looks good on paper, and what actually works—we are hoping to be able to understand that better after the races," he said.

When the CTC Engineers weren't preparing their submarine for ISR, they were building a water-remediation system for a school in Adama, Ethiopia. Part of the team traveled to Adama just two weeks prior to the competition to install the system, and made it back just in time to race.

Two Florida schools overcome a hurricane as they prepare for Maryland submarine races

By Brooke Marquardt,
NSWCCD Public Affairs

Not even a hurricane could stop some Gulf Coast High School students from returning to the 2019 International Human-Powered Submarine Races (ISR) at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland. Two teams came from Florida under Gulf Coast State College (GCSC) affiliation: Engineering-Minded People and the GCSC Sub Club. Engineering-Minded People is a club at the Gulf Coast State College in Panama City, and the GCSC Sub Club is from the Gulf Coast High School in Naples.

For the past year, these two clubs have shared a budget and materials while building two submarines in preparation for the 2019 ISR, which was June 24-28. The college team started with 10 people and now has only two, so the clubs share support divers, as well. This is the high school team's second time at ISR and their submarine, Son of Trigonus, is an improvement on their last sub, Trigonus. The college team submarine's name is Commodore, their school mascot.

"We looked at previous races and saw the different designs people were doing and hydrofoil seemed to be the most



Students from Gulf Coast State College and Gulf Coast High School in Florida stand with one of the submarines at the International Human-Powered Submarine Races on June 24, 2019, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Ryan Hanyok/Released)

successful. Since it had already been tested, we went with that and improved on it," said Robert Copsey, a junior studying mechanical engineering at GCSC.

When the GCSC Sub Club decided that they wanted to return to the ISR, they enlisted the help of the Engineering-Minded People club about a year out from the race. This was the first year that the Engineering-Minded People club had a submarine at ISR. When the clubs started working together, they had about a year to build on an old submarine to create a new one, but then Hurricane Michael hit and took away almost three months of work, leaving the teams about eight months to pull off the designs.

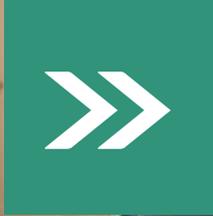
The original Trigonus was made up of corrugated plastics and fishing line, but because of the octagonal shape, it kept collapsing. The GCSC Sub Club then used additive manufacturing and carbon fiber to design the Son of Trigonus with a budget of just under \$400.

"Because this event allows high school and college students, it gives them an opportunity to do the hands-on engineering work rather than just the hypothetical. Allowing this age range to do an event like this is a good breeding ground for new engineers," Copsey said.

"The best part about this event is that we know we're going to be faster than last year, and we'll get to make more attempts. Last year we were only able to make one attempt to make it across the finish line," said Jayden Bernard, recent graduate of Gulf State High School.

Another recent graduate, Mia Evans, agreed and added, "It's an experience like no other. Hardly anyone gets to say they've built a submarine, and now I'm dive-certified and can go scuba diving whenever I want."

Plongeur 2	Frank	Billy
Maitre Plongeur	Nathan	Maquin
Pataugeur	Styves	Rémy
Remorqueur	Oli	coubeau
Agent de liaison	Rémy	Oli
Pilote	Nathan	tony
Substituant	tony	Félix
	Félix	Félix



Quebec's Omer 11 is big winner at international sub races in Maryland

By Edvin Hernandez, NSWCCD Public Affairs

Students from L'École de Technologie Supérieure (ETS) have established themselves as regular competitors at the International Human-Powered Submarine Races (ISR), travelling from Montreal, Canada, to West Bethesda, Maryland, to compete since 1992. The ultimate underwater competition, sponsored by the Foundation of Underwater Research and Education, is held biennially at Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin, which is home to the Navy's longest tow tank facility.

The Canadian-based team wasted little time at the time trial races this year. Their sub, Omer 11, was the first human-powered submarine to pass a wet inspection test and successfully complete a time trial run on the first day of the competition. While other teams were still fixing their vessels to meet the requirements of the mandatory wet inspection test, Omer 11 finished their first day strong, with five completed runs.

Omer 11 recorded its fastest time on the second day of the races, clocking a speed of 5.8 knots. Each year, the crew draws inspiration from Omer subs in the past, produced by former ETS students, to develop innovative designs that will help their sub meet the demands of the ISR.

“We were doing Omer 10 two years ago when a lot of our old members were finishing up their bachelor's degree,” said co-captain Guillaume St-Yeys. “The goal was to do a submarine in one year and collaborate with all the new members. For the non-propeller system, we kept the inspiration of the Omer 10 submarine. The difference is that we optimized the non-prop system with our new team and put it in the Omer 11, which is the same ship as the previous hull, just newer.”

Alterations to the Omer 11 did not stop there.

Team Spotlight



Omer 11 pilot Felix Garneau wipes down L'Ecole de Technologie Supérieure's submarine before entering Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin for day three of the International Human-Powered Submarine Races in West Bethesda, Md., on June 26, 2019, in West Bethesda, Md. (U.S. Navy photo by Edwin Hernandez/Released)

“We wanted a bigger challenge. That’s why we were the first submarine to put a propeller and non-propeller system in our sub, to be eligible to compete in both categories,” St-Yves said.

The ETS team challenged themselves further by adding a propeller system that has variable pitch and cambered blades to help it maneuver more smoothly in the water.

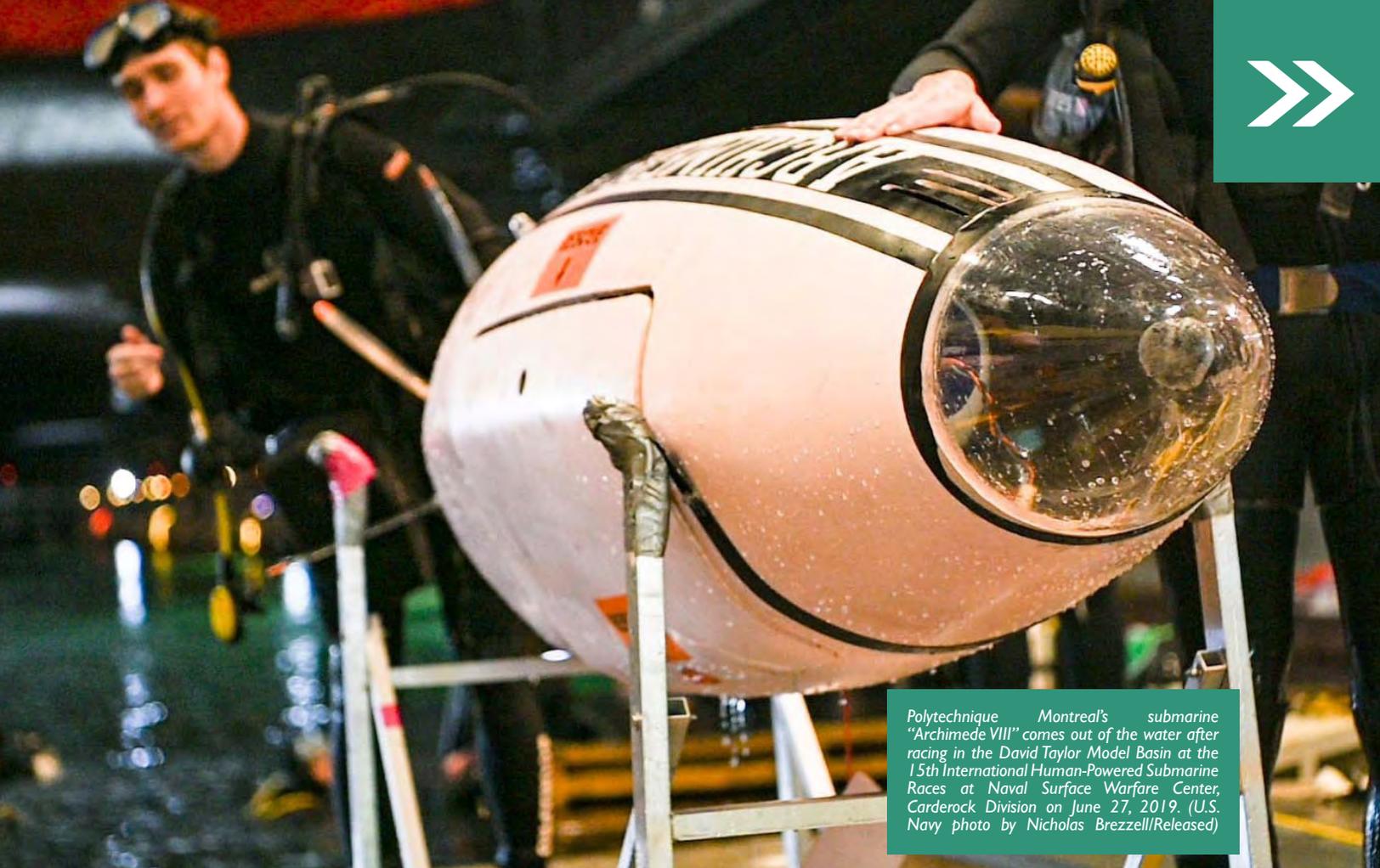
“Our team designed our buoyancy at a 45-degree angle so when the torque of the blade comes, it goes in a straight line. We put some lead on one side and foam on the other side to get the submarine shifted more on the right,” St-Yves said.

To make the Omer 11 faster, the crew also added a stabilizer to their sub’s configuration. They ran a computation fluid dynamics analysis to measure the amplitude needed for the shape of their submarine.

Even the fins on the submarine were made in new rubber material, allowing the team to adjust the tension.

“Last year, with Omer 11 (at the European International Submarine Races), we did not have a wrap like we have today,” St-Yves said on June 27, the day before the final push for the highest speed. “It was handmade paint, but it was bumpy and created a disrupting drag forcing us a little to the left. For this year’s competition, we decided to strip the coating off and get it right with vandal paint on the high and low spots of our sub. Then we wrapped it and made it slicker than last year for improved speed.”

Omer 11 nearly swept the competition this year, getting the highest speed of 6.85 knots on the last day. They also took the Innovation Award, the Best Spirit of the Races Award and the Overall Performance Award.



Polytechnique Montreal's submarine "Archimede VIII" comes out of the water after racing in the David Taylor Model Basin at the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division on June 27, 2019. (U.S. Navy photo by Nicholas Brezzell/Released)

Polytechnique Montreal races in remembrance at 15th ISR

By Benjamin McKnight III, NSWCCD Public Affairs

While 1989 represents the beginning of the International Human-Powered Submarine Races for most of those involved, for Polytechnique Montreal Technological University, it is a reminder of a much more somber time.

On Dec. 6 of that year, a gunman walked onto campus and killed 14 women in an attack that rocked the entire nation. In preparing for the 15th ISR, the Polytechnique Montreal team knew that they wanted to honor the memory of those victims during the 30th anniversary of the attack. Returning to Carderock to build off their 2017 performance as the second-fastest college team with a one-person propeller submarine, the team donned light-pink shirts with a submarine to match.

This year's model of Archimede is a complete redesign of the previous model, a strategy that team member Colin LaPierre-Fecteau said is a regular practice for the squad.

"This one is smaller, especially on

the side. It pretty much comes to hip width," LaPierre-Fecteau said. "It's 15 percent smaller in length and height from the last submarine we had."

A full overhaul comes with challenges as the trial and error process exposes the capabilities of the teams. Therefore, while teammate Alexander Richard pointed out the new transmission and pop-up buoy installed, not everything that Polytechnique Montreal tried was successful.

"We wanted to integrate an electrical steering system this year," LaPierre-Fecteau said. "It worked, but there was a mechanical failure in the mechanism, so we switched to our backup system which is fully mechanical."

Going into the week, the team had a very particular goal in mind: starting fast. Although testing happens throughout the submarine-building process for the teams, the uniqueness of the David Taylor Model Basin forces even the most prepared squads to test as they go during

the week. Making those adjustments often results in prolonged time lapses between when a team is allowed to begin and when they actually cross the starting line, an issue that Polytechnique Montreal proudly seemed to have mitigated.

"When we are on the race course, we don't take up much time," Richard said.

What this team did not have on their side for 2019 was experience, as this year's team comprised nearly all first-time competitors.

Richard was not too concerned with the lack of familiarity for the group, noting that it was important for them to use this week as an opportunity to prepare for the future.

"We want to gain some experience so that in the next years, we'll have that built up experience in the competition," he said.



Kids into Discovering Science bring a taste of Maryland to Carderock

By Brooke Marquardt, NSWCCD Public Affairs

The Kids into Discovering Science (KIDS) team from Accokeek, Maryland, handed out packets of Old Bay Seasoning to anyone who stopped to take a picture in their photo booth at the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland.

“The kids agreed to do a photo booth to draw people in and be able to talk to them about their submarine, some pieces that they’ve made themselves. We also made a ‘discovery cart’ to display our work,” said Katharine Vincent, one of the KIDS sponsors.

The photo booth included a wavy background and hand-made props to hold up. The team also had what they called an electrical workshop on one of the tables under their tent to show off what their group of high school students designed for the electric steering mechanism for the submarine.

KIDS is a non-profit, interactive organization that hopes to make learning about and designing things in science and engineering fun. The program is for all age groups between kindergarten and high school. It started out as four families interested in building

a submarine for different races, but when they tested one of their subs in a local pool, interest grew so much that they went on to create the non-profit.

“We put an emphasis on hands-on learning in STEM (science, technology, engineering and math) and project management for K-12 kids,” said Paola Addamiano-Carts, one of founders of the organization.

The work this year was divided up by systems, not age, and whoever was interested got to work on that system alongside an engineer mentor.

“The kids did all the work. It’s learning by doing,” Vincent said.

Liam Vincent was one of the kids at the local pool the day the group was testing the submarine and has been involved ever since, almost 10 years. He is going to be a junior in high school in the fall and is a project manager for KIDS.

“It’s my job to make sure that everybody is involved, that everyone has a role and that we’re targeting their interests,” he said.

For this group, it is not uncommon for the kids to be involved for years at a time.

One of their surface swimmers, Sophia, has watched her sisters grow up and out of the group, but she is a year too young to be in the submarine and said she is looking forward to doing it next year.

To learn more about this organization, click here: <http://www.kidsinscience.org/>.

Team members from the Kids into Discovering Science program in Maryland pose with their handmade props for the photo booth under their tent at the 15th International Human-Powered Submarine Races on June 25, 2019 at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Brooke Marquardt/Released)



Sussex County returns to ISR with new UmptySquatch

By Brooke Marquardt,
NSWCCD Public Affairs

For Sailors, an umptysquatch is the equivalent to when civilians say “thing-a-ma-jig,” referring to an object that’s actual name cannot be remembered right away. For a New Jersey high school, it is the name of their human-powered submarine.

The UmptySquatch comes from the Sussex County Technical School in Sparta Township, New Jersey. The teacher that manages this team is a retired Navy lieutenant and allegedly told his students that there was no way he would show up to a naval basin with a name like that, but the name stuck. The team of 30 high school students that made up this team were enthusiastic and claimed this was the best year that they have had to date.

“This was barely an idea last September, so in about 10 months we saw it grow into something that actually works. To see it work the way you expect it to is amazing,” Zachary Rauchbach said.

“It’s also amazing to be a part of such a big team and to be working like a well-oiled machine is just an amazing experience to be a part of,” said Joshua Rubenstein. Rauchbach and Rubenstein will be seniors when they return to school in the fall.

Students from Sussex County Technical School in Sparta Township, New Jersey, work on UmptySquatch, their submarine for the 15th International Human-Powered Submarine Races, on June 24, 2019, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Ryan Hanyok/Released)



Team Spotlight



Members of Texas A&M University's submarine team work on 12th Manatee after completing their wet test on day one of the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division on June 25, 2019, in West Bethesda, Md. (U.S. Navy photo by Benjamin McKnight/Released)

Meet the team: Texas A&M University

By Benjamin McKnight III, NSWCCD Public Affairs

Nearly 100 years ago, the story of Texas A&M University's "12th Man" was born. The long-respected tradition for college sports fans across the nation is a way of life in College Station, Texas, that has made its way to Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland.

Texas A&M returns to Carderock for the 15th International Human-Powered Submarine Races with 12th Manatee, a nautical ode to the school's fandom. The Aggies are one of many teams in the competition who have been participating since its origins in the 1990s. This year's squad has a wide range of experience from first-timers and ISR veterans, all contributing to their uniquely designed two-person submarine.

"One of our main challenges was since it is a two-person submarine, we have two people peddling and two sets of propellers going opposite of each other," said team member Mitchell Disbrow, a first-time competitor.

According to his teammate Peter Blank, a returning participant to the competition, the group began their work with a design given to them from a class of students about a decade ago. They

ran into issues early in their three-year process with 12th Manatee, but the timing couldn't have been any better for the Aggies, who are the only team this year with a two-person submarine.

"It gave us a chance to start from scratch and rework the whole thing so that we could have a much more simple and manageable system that worked," Blank said.

"It's completely redone from the inside. The only thing that's similar is the hull," said Daniel Toerner, who is also competing for the first time after coming to watch his sister participate in previous years.

The team hopes to reverse course from their last trip to Carderock, where Blank said they spent a considerable amount of time working on the submarine during the competition.

"Right now, our biggest goal is finishing a race and progressing to see how fast we can get it from there," Blank said.



President of the University of Southampton's submarine society, Maria Stagno Navarra (left), and team member Gareth Caine assemble the control system to their submarine Tempest on June 27, 2019, while support diver, Samantha Middleton watches during the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Nicholas Brezzell/Released)

Tempest, the fighting submarine

By Edvin Hernandez, NSWCCD Public Affairs

Down by the south coast of England, a group of students from the University of Southampton came together to create a human-powered submarine that fought its way to the 15th International Human-Powered Submarine Races (ISR) June 24-28, the biennial event at Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin in West Bethesda, Maryland.

An American student, Adam Studebaker, created the British school's first submarine society after drawing inspiration from the University of Michigan's submarine club while on a college tour.

"Our society was inspired by the University of Michigan," Studebaker said. "When I was looking for universities, I saw the University of Michigan's workshop and learned about the human powered-submarine races. So in my second year, I decided to start up this society for the University of Southampton."

Studebaker explained that the society has faced its fair share of challenges, especially with budgetary constraints,

but has always managed to make ends meet in time for competitions.

"Money was tight, but one of our team leaders designed a really hydrodynamic hull," said Maria Stagno Navarra, president of the society. "We conducted a computational fluid dynamics analysis and it came out with a low drag coefficient, which was perfect. Unfortunately, we didn't account for people not being able to manufacture the nose cone because it was too big or too expensive."

In the end, the team decided to use a flat packable nose cone instead.

The team's sub, Tempest, has attended three ISR events in the past, but faced their toughest challenge yet at this summer's races. The one-man propeller submarine was shipped in advanced and arrived in the United States three weeks before the ISR event was set to begin. While many teams would have felt relieved that their sub arrived, the British team's Tempest was still an unfinished product.

Gareth Caine, the team's transmissions

co-lead, revealed there was a lot of stress involved in getting their submarine to be operational, but emphasized that the team remained in high spirits throughout the week-long races.

"The team invented, tested and built the entire control system on Tuesday at Carderock," Caine said. "Home Depot should maybe hire us."

Although the team did not pass their wet inspection test until the penultimate day of the races, they remained upbeat and proud of their extraordinary turnaround.

"We are all really proud of what we have accomplished here at these races," pilot Oliver Heilmann said. "To turnaround an incomplete submarine and get it in the water for a time trial run was not easy, but we did it," said Heilmann.

Tempest will make its next appearance at the European International Submarine Races in Gosport, England, next summer.

Godiva III is worth the grades

By Brooke Marquardt,
NSWCCD Public Affairs

The University of Warwick's submarine, the Godiva III, was worth a quarter of their final grade for the students building it. Six recent graduates travelled from Coventry, England, to participate in the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland, June 24-28.

Building a submarine is an academic project for them, and has been a tradition of this program for years. As a part of their master's degree program, they spend about a year building and testing the submarine before taking it to various competitions.

"The whole idea is that we work together, that we learn how to work together as people and as different types of engineers. Our reward is that we get to come across the sea and participate in this event," said Sarah Kemp, a master's student and the Warwick team's only pilot. They described coming to the ISR as the cherry on top for all of their hard work.

Each year, the University of Warwick has a new group of students to improve on the past year's submarine, hence the third iteration of Godiva. The first-ever submarine from the University of Warwick was Shakespeare, composed of two bathtubs and the majority of parts from a bicycle. Though the submarine is recycled each year, there are no original parts on the Godiva except parts of the hull.

In the middle of the week, Godiva III crashed into a wall and broke one of their propellers, almost ending their runs. Luckily, Carderock engineers were on site to help with issues like these and laser-scanned the broken piece to 3D print another for them.



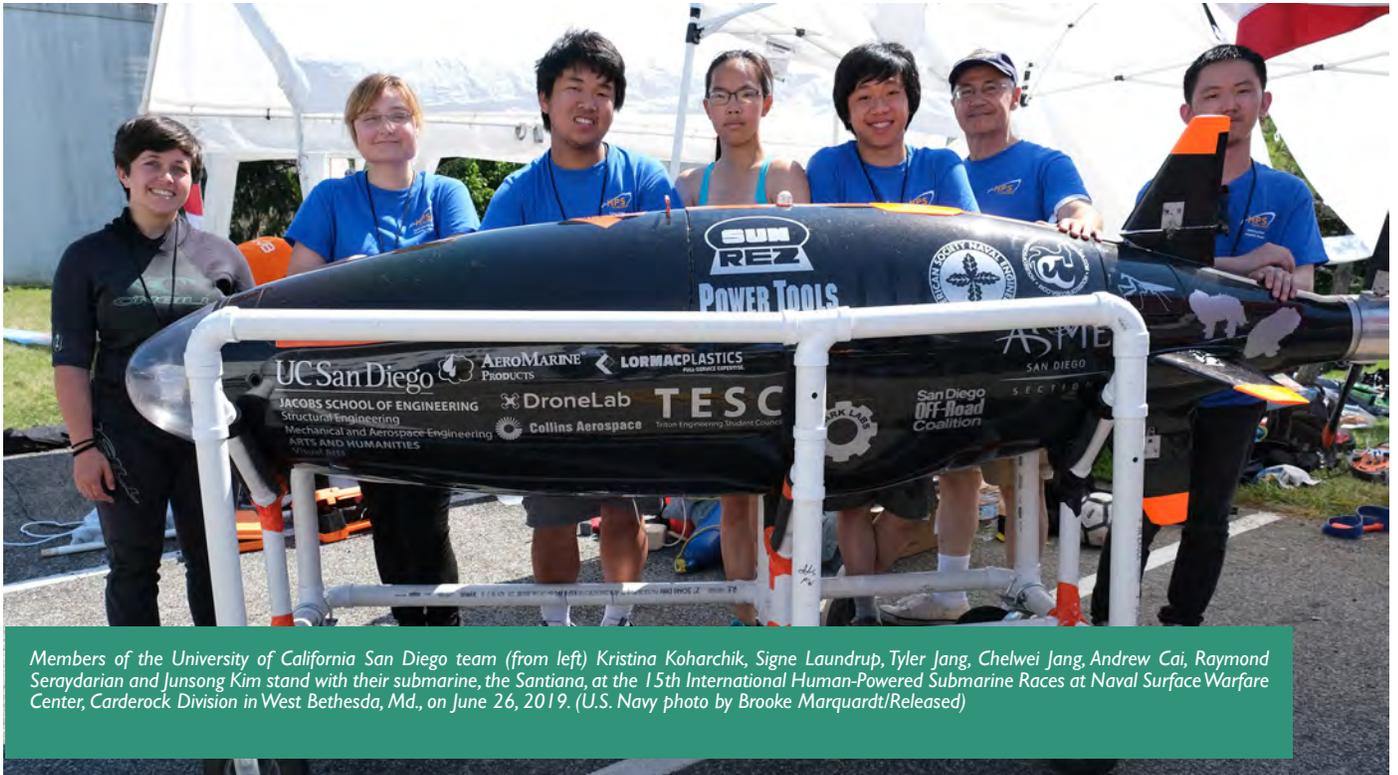
"Some of the teams showed up with generators and their own 3D printers, and all we have is a toolbox, so we're grateful," said Helen Boyle, a recent graduate who is going to work for Dyson Industries later this year.

Sarah Kemp, the pilot of the University of Warwick's submarine, Godiva III, stands in front of the David Taylor Model Basin holding her team's broken propeller on June 27 during the 2019 International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md. (U.S. Navy photo by Brooke Marquardt/Released)



San Diego team redesigns submarine for 2019 races

By Brooke Marquardt, NSWCCD Public Affairs



Members of the University of California San Diego team (from left) Kristina Koharchik, Signe Laundrup, Tyler Jang, Chelwei Jang, Andrew Cai, Raymond Seraydarian and Junsong Kim stand with their submarine, the Santiana, at the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md., on June 26, 2019. (U.S. Navy photo by Brooke Marquardt/Released)

The University of California San Diego (UCSD) brought their submarine, the Santiana, cross-country to compete in the 15th International Human-Powered Submarine Races at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland.

The Santiana was created from the hull of their old submarine, Spicy Tuna Roll, after they finished competing in the European International Submarine Races, held in Gosport, United Kingdom. The team revamped the fiberglass hull and added a propeller. They did not intend to use propeller propulsion, but ran out of time.

The UCSD team was excited to talk about the resources made available to them through their campus to build their submarine. Each student was able to become machine-shop certified and then had access to other engineering labs. In one of the labs, they were able to use a water jet to cut parts for the Santiana.

Andrew Cai, a junior studying mechanical engineering, was most proud of their safety systems.

“One of the unique things about our safety system is our

dead-man buoy retention system. Whereas most teams just have their buoy attached to some sort of cable or rope, that has to be manually reset, ours is on a spring that reels itself in, sort of like a tape measure,” he said.

The team was most excited to see their final product in action. They recalled a feeling of vindication for all of their hard work when they saw the Santiana cross the finish line on their first run.

“Our team has a very open-ended atmosphere and that’s what really drew me in in the first place,” Cai said. “It felt like less of a club and more of a group of friends who happened to be working on the same project.”

Team Spotlight



From left: Shelby Quiring, Juyeong Oh, Allysia Lam and Katherine Westerlund make minor fixes to Skookumchuck, the submarine for University of British Columbia's submarine team, on June 25, 2019. UBC returned to Naval Surface Warfare Center, Carderock Division this week to compete in the 15th International Human-Powered Submarine Races, taking place in its 3,200-foot David Taylor Model Basin in West Bethesda, Md. (U.S. Navy photo by Benjamin McKnight III/Released)

Skookumchuck races at Carderock

By Benjamin McKnight III, NSWCCD Public Affairs

A road trip from British Columbia, Canada, to Naval Surface Warfare Center, Carderock Division planned on Google Maps takes roughly 44 hours. University of British Columbia's submarine team SUBC did not let the length of a cross-country drive deter them from competing in the 2019 International Human-Powered Submarine Races.

SUBC is one of eight international teams competing this year and a regular participant in the races. Racing for SUBC is Skookumchuck, their submarine named as a tribute to British Columbia's indigenous language Chinook Jargon, translating to "white water" or "rapids." Their submarine won't be racing through rapids, but rather the David Taylor Model Basin as they hope to come out victorious in the event.

Allysia Lam is a first-time competitor for SUBC, being drawn in by the prospect of getting more opportunities to practically apply what she is learning in her mechanical engineering program.

"I really liked the idea of a submarine, and I have a scuba diving certification, so it seemed like I would get to build a super cool thing and also get a bunch of diving buddies," Lam said.

That super cool thing is noticeably larger than the submarine SUBC raced in 2017. ISR veteran Shelby Quiring said that their last vessel was one of the smallest submarines in that competition, so this year the team made one that would allow them to shuffle through multiple pilots if need be. Making Skookumchuck larger also alleviated the space constraints for the equipment inside that they dealt with in their previous competition.

"We did a lot of redesign and iteration based on what we learned at the last competition, and we were able to have a system that functions much better," Quiring said. "Everything has to be okay to go underwater, so a lot of components that you would regularly buy off the shelf that contains anything that corrodes are a no-go."

To get to Carderock, SUBC spent four days on the road. University of Victoria, another team in the competition, faced a similar dilemma with their submarine transport, so the two schools teamed up to make the trek from the Northwest.

"It's a bit of a journey but it was definitely worth it to be here," Quiring said. "The drive was a lot of fun, a little chaotic."

"And a lot of music," Lam said.

A win for SUBC would be the icing on the cake of a lengthy process, but one of the team's major focuses is building a strong bond among the team through accomplishments and adversity. They also plan to glean learning points from the results from the other teams' efforts as the week progresses.

"The other teams have all the same problems as us, and we all still have very different submarines," Lam said. "It's very interesting to ask them about their design process and see what kind of deviations they made from ours."



Members of University of Washington's Human-Powered Submarine team adjust The Underdawg during the 15th International Human-Powered Submarine Races on June 25, 2019, at Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin in West Bethesda, Md. (U.S. Navy photo by Benjamin McKnight III/Released)

Meet the Team: University of Washington

By Benjamin McKnight III, NSWCCD Public Affairs

Everyone loves a good underdog story and the University of Washington's Human-Powered Submarine Team is no different. Although the Huskies are a familiar name to the International Human-Powered Submarine Races as participants since the very first race, it was almost a no-brainer that the team name their submarine The Underdawg as they geared up for this year's competition.

"We were soliciting suggestions from people, and then we voted as a group. People liked The Underdawg for a number of reasons," said Ahrif McKee, Washington's drive-train lead.

At the last ISR in 2017, Washington placed second in the innovation category for using a wooden hull in collaboration with the Northwest School of Wooden Boatbuilding in Port Hadlock, Washington, and first in the two-person submarine category. While those two achievements are impressive, the team knew that they could accomplish greater in their return to Naval Surface Warfare Center, Carderock Division, even if it meant a little more work on their end.

"This year's sub is a one-person

submarine, because with the two-person sub, although theoretically you can go faster because you have twice as much manpower, it's twice as complicated," said Lucas Campbell, a member of Washington's controls team. The Huskies also chose to leave the wooden hull concept in 2017, citing a desire to bring the hull construction back in-house while learning as they go.

"A number of the team leaders decided that the amount of knowledge we could gain from building the hull ourselves is just tremendous," he said.

Another team focus this year was not making the submarine so small that they could not fit the necessary systems inside, and at the same time, not so large that they lose speed in the process.

"The marriage of those two things was difficult, because the bigger your sub is, the more room you have, but then the more water you have to move and the more drag you're going to have," McKee said.

Controlling the entire submarine-building process for The Underdawg has given the Huskies a boosted sense of pride coming

into the 2019 competition. Both Campbell and McKee are longtime members of the submarine team, joining as freshmen after receiving email blasts about possible clubs to join on campus. Years later, the fruits of their labor are visible not only in the ISR, but in the industry, as well.

"Being on this team for the past four years, nearly every professional opportunity that I have gotten has either been directly or indirectly linked to the experience I gained on this team," said Campbell, as McKee agreed.

Staff advisor Ryland Bryant noticed that even in the spirit of competition, there is a unique sense of camaraderie displayed among the teams, whether it is sharing equipment or applauding other squads as they finish a run.

"Whenever a team completes their first run, everyone in the basin is cheering. It's a really special event," McKee said.

"That's why I keep coming back," Campbell said.

Inside the Chinook II, a University of Victoria human-powered submarine

By Edvin Hernandez, NSWCCD Public Affairs



Submarine pilot Jaryd Middleton test-drives the “Chinook II” at the University of Victoria’s McKinnon pool in preparation for competing in the 15th International Human-Powered Submarine Races taking place at Naval Surface Warfare Center, Carderock Division in West Bethesda, Md., June 24-28, 2019. Dive leads Garrett Reid and Aryana Wilson offered guidance to Middleton. (Courtesy photo by Santiago Gutierrez)

Jaryd Middleton, pilot and president of Canada’s University of Victoria’s Submarine Racing Club from British Columbia, Canada, was once a part of a submarine team populated with senior students when he was just entering college. Many of them have now graduated, ushering in a new era of young science, technology, engineering and math team members. Although they are new to each other and their roles within the club, all members have hit the ground running after seizing the opportunity to learn and improve from the team alumni.

This summer marks the first appearance for the team’s “Chinook II” human-powered submarine at the Foundation for Research and Education’s 15th International Human-Powered Submarine Races (ISR), which are being held June 24-28, 2019, at Naval Surface Warfare Center, Carderock Division in West Bethesda, Maryland. Before assembling Chinook II, however, the team encountered several obstacles. In a year’s time, the team had to accrue sponsors, money and new team members before thinking of a conceptual design. Only then could they begin to research ways to reach top speeds for this year’s submarine time trials.

Unlike the European International Submarine Races, which the Chinook II team participated in last summer in Gosport, England, this year’s ISR challenge focuses on speed instead of a sub’s turning radius and maneuverability.

“This year we made a lot of modifications,” Middleton said. “The last competition we went to was focused on maneuverability, and we tried out some design elements to accommodate what we needed. For example, we installed a nozzle in the back of our sub with the idea that it would duck the water coming off the blades. However, after some analysis we found out that the nozzle was creating as much drag as the whole sub.”

But like last year, there were alterations to be made for ISR.

“We have little set screws on the side of our hull, and we have three different sizes of control services,” Middleton said. “So if we find that we’re not getting enough steering underwater, then we can actually change out the control services. This also allows our pilot to get familiar with the submarine and have some training wheels for control.”

Before teams can run a time trial race, a mandatory wet inspection must be completed. At Carderock, teams are given the opportunity to tinker with their subs to meet the requirements throughout the week, but they, along with other teams, have been learning through trial and error.

“There isn’t a textbook on how to build a human-powered submarine, so a lot of it was coming up with your own ideas on how to do things and doing a lot of practical problem solving,” Middleton said. “Trial and error pretty much.”

Prior to arriving and conducting tests at ISR, the Chinook II team has been testing their vessel at the McKinnon pool inside the University of Victoria. It stretches a length of 80 feet, but the team revealed that Carderock’s 3,200-foot David Taylor Model Basin was a unique facility.

“Often we were unable to test our sub properly because this type of pool is very rare. This competition and the one in Gosport are both on Navy bases so – even at the competition there’s fine tuning and we’re always learning as we go,” Middleton said.



The Trident, one of the submarines designed and built by Virginia Tech engineering students, gets ready to launch for the first races of the day in Naval Surface Warfare Center, Carderock Division's 3,200-foot David Taylor Model Basin on June 25, 2019. The Trident is one of 21 submarines built by students from around the world participating in the 2019 International Human-Powered Submarine Races. Pictured from left are Virginia Tech students Grey Quesenberry, Selim Odok, Audrey Coral and Katie Judge (holding Neptune's trident). (U.S. Navy photo by Benjamin McKnight/Released)

A tale of two subs: Virginia Tech succeeds at ISR in Carderock

By Benjamin McKnight III, NSWCCD Public Affairs

Veteran members of the Virginia Tech Human-Powered Submarine team remember the last time they were at Naval Surface Warfare Center, Carderock Division and are back with a vengeance.

The Hokies participated in the 14th International Human-Powered Submarine Races two years ago, failing to place in any of the categories. This year, Virginia Tech has returned to Carderock with a revamped version of their Phantom series submarine and added a second submarine to their team, making them the only college team with two boats in the competition. Phantom 8 and Trident are the results of two years of hard work for the Hokies.

“For Phantom 8, it was a lot of redoing other people’s work because as a multiple-year project, it was started before we were on the team,” said Curtis Mussen, the team’s president. “With Trident, we didn’t really have anything built so that allowed us to do what we wanted, but it was a lot more work in terms of planning, manufacturing and it cost more, too.”

While extra time and money is a natural concern for any project, Virginia Tech knew it was a price they were willing to pay to upgrade their output. They also included personnel development as part of the team’s improvement plan in the new submarines’ design cycles.

“One of the biggest issues was team members not being trained on a lot of different things, so we took scuba-diving training, as well as welding and composite training,” Mussen said. “We spent about six months getting various certifications, and I think it’s really shown this year with how much smoother the operation is going.”

Bringing two vessels to the competition has proved beneficial so far for Virginia Tech. Phantom 8 has required the team’s attention for adjustments during much of the competition, but has been offset by the Trident’s successful runs.

“Phantom 8 is actually one of the submarines that went into the competition with very little in-water experience, so putting it in the water and trying to

race it for the first time, a lot of systems failed,” said design team head Rykley Cooper. “For Trident, we decided to put a lot of emphasis on our testing, so it’s been in the water a lot over the past semester to make sure the systems work.”

Nevertheless, the Hokies enjoy the experience of each trip to the ISR. Being one of the relatively local teams in the races makes the journey to Carderock a little easier, but that also comes with added pressure to be competitive.

“Once we’re here we get more pressure, because we meet alumni from our school and they’ll ask us how we’re doing. This year, we can say we’re doing great,” Mussen said.

Building for the future remains the main objective for Virginia Tech. According to Mussen, coming back to the 16th ISR in 2021 without having to revamp this year’s work will be the greatest indicator of success.

Team Spotlight

Wasub IX crosses the Atlantic Ocean to compete at submarine races at Carderock

By Edvin Hernandez,
NSWCCD Public Affairs

Located by the East Coast of the Netherlands is Delft University of Technology, a school that aims to send new human-powered submarine teams to the biennial International Human-Powered Submarine Races held at Naval Surface Warfare Center, Carderock Division.

At the David Taylor Model Basin in West Bethesda, Maryland, teams like the Wasub IX have developed their vessel from scratch. The process of creating a one-man propeller submarine is no easy task. Dhijs Haenen, Eindhoven University of Technology student and pilot of the Wasub IX, explained that his body had to be molded into the structure of his team's submarine before properly constructing the full-scale hull.

"Inside the submarine it is very cramped," Haenen said. "The only thing that fits is my body and my index fingers to steer. We started with a 3D scan, where you stand in a full body 3D scanner in a specific pose and they make a 3D model of you that's exact in every detail. That helps us see if and how it would fit inside the sub and if there is enough room for range and motion."

Financial manager and co-race captain Viren Mirchumal said this year's submarine is different from previous ones because it was designed to accommodate the body attributes of him and Haenen, which has not previously been done.

Wasub IX has also added an electronic steering system to their



Wasub IX engineers Fien Pockele (left) and Niels Pynaert from the Netherlands evaluate their human-powered submarine during the 15th International Human-Powered Submarine Races before entering Naval Surface Warfare Center, Carderock Division's David Taylor Model Basin for a wet inspection test in West Bethesda, Md., on June 25, 2019. (U.S. Navy photo by Edvin Hernandez/Released)

hull, but are vigilantly watching it due to its sensitive nature.

"When you get high speeds, our electronic steering system gets more difficult to control. So, we are tuning that right now to help it become less sensitive," Haenen said. "When I was inside the sub on a time trial run, I was constantly overcorrecting the steering and swerving a bit."

The team was fortunate enough to test their one-man propeller sub in three different pools, inside and outside, before arriving at the David Taylor Model Basin, thanks to their sponsors.

The deepest dive the team recorded was a 13-foot dive in their sponsor's small pool. The team's most successful test run came at an Olympic swimming pool, which was 164 feet long and 9 feet deep.

"It was just enough for the pilot and divers to get used to diving, communication and peddling," said operations manager and co-race captain Charlotte Struigk. After having completed a few time-trial runs, Haenen admitted

that he was worried at first by the tow tank's limited visibility.

"It is very dark when you're not near the light," Haenen said. "The light gives you some depth perception and you can see where you are as long as you stay on track. When you finish the course and the lights stop, however, there is no point of reference, but you have to keep calm."

The team is has 25 team members from different universities including Delft University of Technology, Eindhoven University of Technology and Vrije Universiteit Amsterdam.

Wasub IX reached a top speed of 6.4 knots at the races, the fastest in the competition as of mid-day June 27.



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**Naval Surface Warfare Center, Carderock Division
Corporate Communications Division
9500 MacArthur Blvd. • West Bethesda, MD 20817-5700 • 301-227-4465**