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SeaPerch and SeaGlide Camp Implementation

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Along with assisting undergraduate students with their class projects, I also help our research professors at Innovation Drive with fabrication of parts or any other needs that may arise for their lab.

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Abstract

This paper provides a summary of the activities and format of SeaPerch and SeaGlide camps held at George Mason University in the Summer of 2022. Each camp was four days, Monday-Thursday, with the SeaPerch camp recruiting middle-school aged students with no pre-requisite robotics knowledge and SeaGlide targeting high-school students with some prior robotics experience. In an effort to recruit a diverse camper population, both camps were offered free of charge to enrolled campers. SeaPerch and SeaGlide foster hands-on engineering and technology experiences with their kit-based robotics programs. Supporting activities during the camps provided students opportunities to leverage engineering, design, science, teamwork, and art skills. Similarly, to increase student interest in research, both camps offered grade-appropriate exposure to fundamental research activities at Mason.

Keywords

Summer camps, underwater robotics

Introduction

As part of an NSF funded effort in maritime robotics, we created two four-day maritime robotics day camps targeting middle and high school learners using RoboNation's SeaPerch and SeaGlide kits respectively[1]. SeaPerch is an inexpensive underwater robotics program that provides students the ability to build their own low cost, remote controlled underwater vehicle, learning concepts like Archimedes' Principle and skills such as soldering. SeaGlide introduces students to maritime autonomous systems as they build an underwater glider out of a water bottle and an Arduino board. The team has past experience in development and leading SeaPerch activities at a range of grade levels, though had not yet used SeaGlide in a camp setting. SeaPerch activities in a number of contexts are well documented in ASEE literature, including presentations to the Pre-College Engineering Education, Women in Engineering, Ocean and Marine Engineering, Mechanical Engineering, and Multidisciplinary Engineering Divisions (see, for example: [2-17]), though less information is available on implementation of SeaGlide programs. The sections below describe the planning and scheduling aspects of both the SeaPerch and SeaGlide camps, which built off prior experience, and also capture feedback and lessons learned for future camp planning.

Planning

Planning considerations focused on five key areas: venue, working with minors, health and safety, cost mitigation, and participant recruitment.

Venue

Both the SeaPerch and SeaGlide programs require a space appropriate for hand tool use as well as access to water for testing. The location selected for this camp was the George Mason College of Engineering and Computing 'Innovation Drive' facility proximal to Mason's Science and Technology (SciTech) campus. This space includes a student prototyping and machine shop space, used most heavily during the academic year for capstone design projects. Additionally, the research laboratories in that building include a maritime robotics laboratory with two water tanks. Photos of both facilities are included in Figure 1.

Figure 1: SeaGlide campers in student prototype space (top); SeaPerch campers in maritime robotics laboratory (bottom)

Minors on campus

Because participants in these camps were minors, background checks were required for all camp personnel and minimum adult to student ratios were also required. While University minimum ratios (1 adult per 10 children for day campers 9-14 years old; 1 adult per 12 children for day campers 15-18 years old) only dictated the need for two adults overseeing the camp, we found it beneficial to have three adults present whenever possible, such that two subgroups could be monitored, while a third adult tended any emergent needs. Mason has a robust and efficient process for hosting programs, events, and camps (PEC) for minors, which facilitated the necessary background checks, provided guidance on risk self-assessment for the camp, required training for counselors, and forms for participants.

Health and safety

Following guidance from Mason's Environmental Health & Safety Office, a Camp Emergency Plan was developed to address potential emergencies. The emergency plan serves as a basis to establish a common understanding amongst the camp team on emergency evacuation plans, and emergency response task assignments from sounding an alarm, to providing first aid, search and rescue, facilities inspection, evacuation, and emergency parental notifications. The University developed plan template provides an outline for responses to severe weather emergencies, missing camper(s), fires, illness or injury, strangers in the camp, water-based emergencies, on-campus violence, utility failure, regional emergency, criminal activity, and evacuation[18]. Additional sections were added to address camper use of hand tools, electrical work, and work near water.

As this camp was held in the Summer of 2022, COVID-19 considerations were still relevant. For our purposes we found two mitigation strategies to prove crucial:

(1) By ensuring we had one additional adult than required on the counselor team, when a counselor developed COVID-19, we were able to proceed with the camps without disruption. Indeed, due to the ongoing pandemic, we made sure additional adults beyond the planned camp team had completed background checks and were prepared to step in if needed.
(2) While camper parents had to agree not to send exposed or symptomatic learners to camp, we proactively offered robotics kits and zoom guidance to the one camper who disclosed a suspected infection, thus mitigating potential desire to press on by the camper.

Cost mitigation

An aim of this camp was to provide robotics experiences to learners who might not otherwise have such opportunities. As such, a key consideration was cost mitigation. External funding offset the costs of kit purchases as well as one faculty and one graduate student's time. The department and college offset the costs of the third counselor's time and provided the venue at no cost. Additional faculty and graduate students volunteered to host mini-activities over the duration of the camp. Camper t-shirts and mugs were provided at no cost by the College of Engineering and Computing's Development Office. Using this collective approach, this camp was able to be offered at no cost to participants. That said, we had a higher than anticipated no-show rate for both camps, and in future years may consider inclusion of a nominal fee in order to guarantee attendance.

Participant recruitment

Due to the offering of the camp at no cost and desire to reach a diverse student cohort, participant recruitment was done through the network developed by the College of Engineering & Computing's Office of Diversity, Outreach & Inclusive Learning.

Schedule

Each camp was scheduled Monday-Thursday, with programming that includes vehicle construction, supplemental activities, and research exposure, with an increased emphasis on research exposure for the high school aged SeaGlide campers. Day by day schedules for the 2022 camp offerings are provided in Tables 1 and 2 below, with further description of each activity in the section that follows.

Day	***Monday***	***Tuesday***	***Wednesday***	***Thursday***
SeaPerch activities	-SeaPerch part 3 – frame assembly	-SeaPerch part 2 – thruster assembly	-SeaPerch part 1 – controller assembly -SeaPerch part 4 – final assembly	-Testing -Obstacle challenge with GoPro
Supplemental activities	-K'nex -Penguin habitat	-Soda and Mentos	-Wave maker -Mars lander	-Paper tower -Games -Photo show
Research exposure		-Graphene experiment	-REU student demonstration	-BlueROV2 demo

Table 1: List of activities during SeaPerch camp

Day	***Monday***	***Tuesday***	***Wednesday***	***Thursday***
SeaGlide activities	-SeaGlide part 1 – power supply & limit switch (with video) -SeaGlide part 2 – buoyancy engine -SeaGlide part 5 – bottle cap prep	-SeaGlide part 3 – circuit board -SeaGlide part 4 – Arduino pro mini -SeaGlide part 6 – buoyancy engine assembly Some learners progressed to -SeaGlide part 7 – bottle prep -SeaGlide part 8 – wing and rudder	-SeaGlide completion -Vehicle testing -Vehicle adornment Some learners opted into building a SeaPerch at this point	-Vehicle testing -Vehicle adornment
Supplemental activities	-Mars lander -Balsa bridge construction	-Balsa bridge testing -BLIMP -Soda and Mentos		-Paper tower

Research exposure	-BlueROV2 demo		-Structural testing demonstration	-IABR tour -ASSIP as a path forward

Table 2: List of activities during SeaGlide camp

As indicated in the schedule, SeaPerch campers were coached in a manner to keep the whole group at the same step of the construction process. This was done deliberately as for many campers this was their first experience working with hand tools or soldering, and therefore for safety considerations, required close monitoring. The high school aged students were able to operate much more independently, and thus given the freedom to progress at their own pace, while being encouraged to help their campmates. Of note, the middle school aged SeaPerch campers were resistant to language involving competition for the final day activities. In future years, language used will emphasize testing and design evolution rather than competition.

Activity descriptions and references

SeaPerch and SeaGlide

- SeaPerch references in Table 1 refer to specific sections of the SeaPerch build manual available in[19]. Steps are done in reverse order from those presented in the manual due to past experience with the SeaPerch program and finding that campers benefit from completing a tangible 'hull' build on day 1 prior to getting into the more detail oriented soldering tasks on the subsequent days.
- SeaPerch obstacle challenge with GoPro – on the final day of the SeaPerch camp, an obstacle course consisting of submerged and surfaced tennis balls as well as pool noodle arches was constructed for campers to navigate their vehicles through. A GoPro was attached to the SeaPerch to provide a perch-eye video of the course. Photos of the course are included in Figure 2.

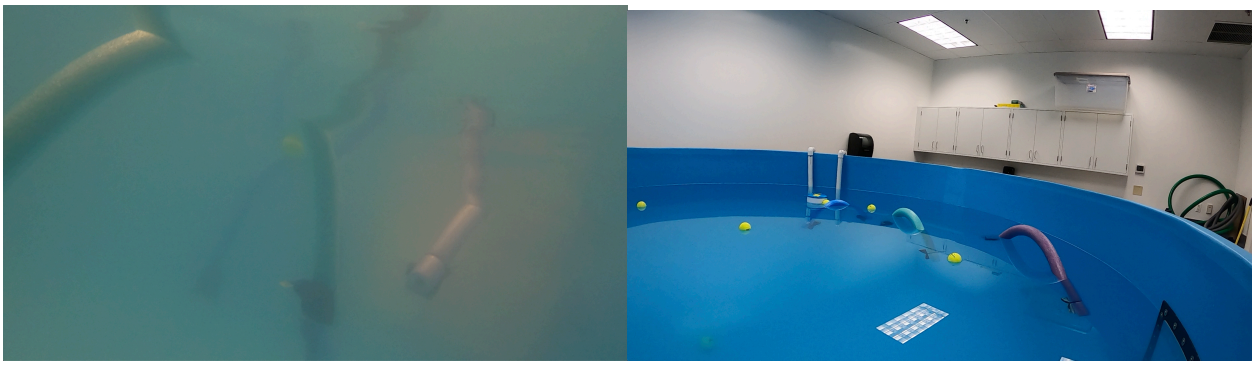

Figure 2: SeaPerch views of obstacle course

- SeaGlide references in Table 2 refer to specific sections of the SeaGlide build manual available in [20]. For the first step, a video tutorial, also available at [20] was shown, though after that initial step, campers largely progressed at their own pace.
- SeaGlide vehicle adornment – it was observed that SeaPerch campers used the kit-included permanent markers to decorate the vehicle's control box. With this as inspiration, multi-colored permanent markers were distributed during the SeaGlide camp, and art-inclined

campers were encouraged to embrace their creativity in decorating their vehicle with camp time specifically allocated to this activity. Sample photos are included in Figure 3.

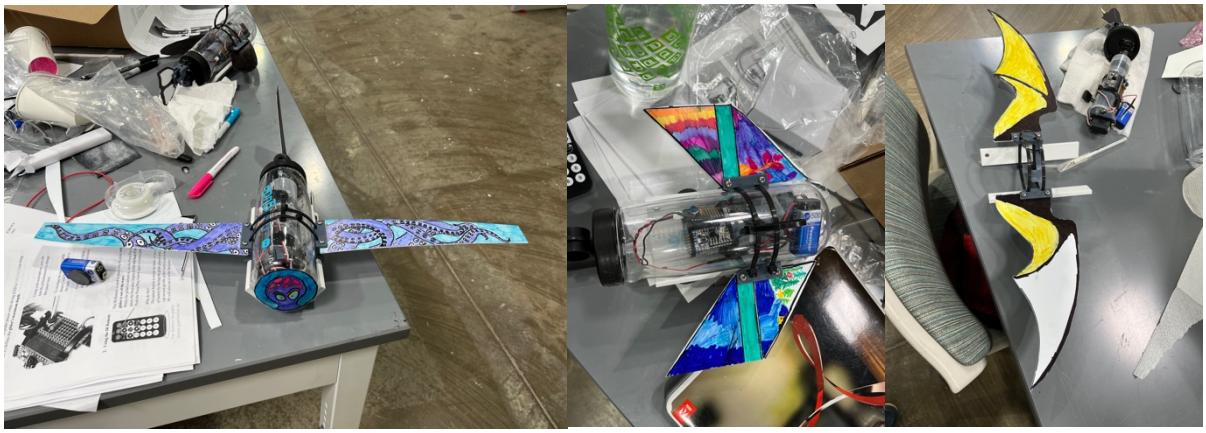

Figure 3: Decorated SeaGlides

Supplemental activities

- K'nex building kits[21] were used as an ice breaker activity for the first day of the SeaPerch camp. Campers were put into teams to construct a bridge using k'nex; the childhood toy proved to be a popular diversion for the duration of the middle school aged camp, and thus kits were left accessible to campers for use during lunch, breaks, or other downtime.
- The penguin habitat activity is inspired by[22]. Leveraging the hot weather of summertime in Virginia, campers are tasked in teams with building a habitat of paper and aluminum foil to keep a penguin shaped ice cube from melting. This activity provides basic exposure to thermodynamics and engineering design alongside teambuilding.
- Soda and Mentos – often a handful of campers have never done a scientific comparison of which soda has the largest reaction with Mentos. In this experiment students follow the process outlined in[23] and compare the height of the soda and Mentos reaction.
- With Office of Naval Research support, an undergraduate researcher developed a wave maker demonstration using a fish tank and paddle style wave maker[24]. Campers were encouraged to experiment with this device to better understand both the control mechanism and the hydrodynamics of wave making.
- Mars lander – this activity is outlined in[25]. Learners built a 'lander' to safely deliver a payload of marshmallows dropped from a height, furthering team building and reinforcing the engineering design process.
- Paper tower – this activity tasks campers with building a structure with paper and tape to lift hypothetical workers, marshmallows, as high off the ground as possible. While for middle-schoolers this served as a fun competition between teams of campers, high school students embraced this as an opportunity to challenge the resident graduate students in the laboratories, furthering the emphasis on providing campers opportunities to envision themselves as future researchers.
- Games – this was simply free time for student driven games.
- Photo show – during the last half hour of the SeaPerch camp, campers gathered to watch a slide show of photos from the week's experiences.

- The balsa wood bridge tasking encourages students to build a structure to span a minimum distance. The bridges are then tested to failure. Students put into practice structural engineering and design skills in this hands-on activity.
- BLIMP – SeaGlide campers were provided the opportunity to test out biologically inspired lighter-than-air vehicles as a side activity during this camp. For more information on the ONR-funded BLIMP program, refer to[26].

Research exposure

- Prof. Pilgyu Kang and his research group engaged SeaPerch campers in the science of graphene by demonstrating how to light an LED with a connection made on paper with pencil lead.
- A Research Experience for Undergraduates (REU) student demonstrated an extension to maritime robotics by showcasing his prototype water sample collection system for SeaPerch campers.
- BlueROV2 demo - both camp offerings provided campers the opportunity to see and drive a research-capable Blue Robotics ROV2[27].
- Kunal Gide, a graduate research assistant in the department of mechanical engineering demonstrated tension testing for the SeaGlide campers, while explaining to them stress-strain relationships.
- To close the SeaGlide camp, campers were led on a walking tour of Mason's Institute for Advanced Biomedical Research (IABR). On this tour they met multiple faculty and graduate students, broadening their scientific exposure during the camp beyond maritime robotics.
- Reinforcing the pathway toward research experiences, SeaGlide campers were provided information on next steps to continue their learning through Mason's Aspiring Scientists Summer Internship Program (ASSIP)[28].

Feedback

Demographic data

As stated previously, a primary objective of these camp offerings was to broaden participation in maritime robotics. Racial and gender demographics of the campers are provided in Table 3.

	SeaPerch (n=11)	SeaGlide (n=11)
Asian	73% (8)	82% (9)
White	9% (1)	9% (1)
Two or more races	9% (1)	0% (0)
Prefer not to say	9% (1)	9% (1)
Male	45% (5)	73% (8)
Female	55% (6)	27% (3)

Table 3: Racial and gender demographics of camp participants

The camps, particularly the SeaPerch camp, had strong gender diversity, but room for improvement in racial diversity. Accessibility was also valued for campers with special needs and/or COVID-19 concerns.

Parent feedback

Parent feedback was resoundingly positive, reinforcing the educational, fun, and inclusive experience we aimed to develop with these camps. Sample comments include:

- "Thanks to you and your staff for running such a great program. [Name redacted] was able to get back to robotics for the first time since COVID and is excited again about pursuing her interest again. Have a great summer!" – SeaGlide camp parent
- "My son [name redacted] had great learning opportunity during the camp. Thank you." – SeaGlide camp parent
- "Thank you, Leigh, for a very educational but yet fun filled week. [Name redacted] had a wonderful time at the camp and can't wait to put her robot to test when we go to the beach tomorrow😄" – SeaPerch camp parent
- "[Name redacted] has been very excited about the process and all of the extra activities. This has been a wonderful opportunity for her. Thank you for making this an inclusive experience!" – SeaPerch camp parent

Next steps

Fundraising

We anticipate grant funding will permit offering these camps again at no-cost in the summers of 2023 and 2024. Long term fundraising and/or an updated budget model will be required to make these camps self-sustaining beyond the grant period.

Long-term impact

It will be of interest to track if camp participants progress from the middle school to high school offerings and/or matriculate as undergraduates at Mason so as to assess the impact of this program on broader diversity, equity, and inclusion goals for the Department, College, and University. No formal exit survey was conducted during the 2022 camp summer; a parent survey may be considered in future years.

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References

1 RoboNation, "Programs," https://robonation.org/programs/, last accessed May, 2021

2 An, E., & Dhanak, M. (2009, June), *A Project Oriented, Team Based Learning Approach* Paper presented at 2009 Annual Conference & Exposition, Austin, Texas. 10.18260/1-2--5101

3 Bates, D. G. M., & Wright, G., & Shumway, S. L. (2016, June), *An Investigation of the Impact An ROV Competition Curriculum has on Student Interest in STEM, Specifically Technology and Engineering* Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26228

4 Batula, A. M., & Mather, T. W., & Carryon, G., & Surrey, S., & Ueda, D. E., & Kim, Y., & Fontecchio, A. K. (2012, June), *Evaluating the Acquisition of Engineering Confidence and Skills Through Robotics* Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--21344

5 Clayton, G. M., & Stein, R. A. (2011, June), *An Inexpensive Hands-on Introduction to Permanent Magnet Direct Current Motors* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17458

6 Consi, T. (2002, June), *Introducing Students To Ocean Engineering* Paper presented at 2002 Annual Conference, Montreal, Canada. 10.18260/1-2--10107

7 Consi, T. R., & Lorrey, J. F., & Kornberg, M. (2018, June), *Beyond the Sea Perch* Paper presented at 2018 ASEE Annual Conference & Exposition , Salt Lake City, Utah. 10.18260/1-2—29849

8 Frye, M. T., & Nair, S. C., & Meyer, A. (2016, June), *Evaluation of miniGEMS 2015 – Engineering Summer Camp for Middle School Girls* Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26784

9 Frye, M., & Wang, C., & Nair, S. C., & Burns, Y. C. (2018, April), *MiniGEMS STEAM and Programming Camp for Middle School Girls* Paper presented at 2018 CoNECD - The Collaborative Network for Engineering and Computing Diversity Conference, Crystal City, Virginia. https://peer.asee.org/29553

10 Giver, S., & Michetti, S. (2008, June), *The Sea Perch Challenge Generating Interest In Marine Engineering, Ocean Engineering, Naval Engineering And Naval Architecture Through Hands On Activities* Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3496

11 Iversen, E. (2016, June), *Engineering Outreach on Campus: A Comprehensive Survey of 109 Programs at 91 Colleges and Universities (Fundamental)* Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26656

12 Nair, S. C., & Frye, M. (2017, June), *miniGEMS 2016 –STEM Summer Camp for Middle School Girls* Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. 10.18260/1-2--28672

13 O'Brien, J. C., & Stein, R. A., & Clayton, G. M., & Wemhoff, A. P., & Nataraj, C. (2011, June), *Exchange: Sea Perch/MATE Science Learning Modules* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2—17951

14 Ozis, F., & Pektas, A. O., & Akca, M., & DeVoss, D. A. (2017, June), *How to Shape Attitudes toward STEM Careers: The Search for the most Impactful Extracurricular Clubs (RTP)* Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. 10.18260/1-2--28451

15 Pannier, C., & Berry, C. A., & Morris, M., & Zhao, X. (2020, June), *Diversity and Inclusion in Mechatronics and Robotics Engineering Education* Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2--34471

16 Wang, C., & Frye, M., & Nair, S. (2019, April), *The Practices of Play and Informal Learning in the miniGEMS STEAM Camp* Paper presented at 2018 Gulf Southwest Section Conference, AT&T Executive Education and Conference Center, Austin, TX 78705. https://peer.asee.org/31557

17 Wright, G., & Hacking, K. (2014, June), *Using ROVs to Teach a Blended STEM Curriculum* Paper presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. 10.18260/1-2—23275

18 Mason Operational Risk Management, "University Camps Emergency Operations Plan**,"** https://risk.gmu.edu/university-camps-emergency-operations-plan/, March, 2021.

19 RoboNation, "SeaPerch Build Manual," https://robonation.org/app/uploads/sites/5/2021/08/SeaPerch-Build-Manual-2021.pdf, last accessed November, 2022.

20 RoboNation, "SeaGlide Build Instructions," http://seaglide.org/build-instructions, last accessed November, 2022.

21 Basic Fun, "K'NEX Think Outside the Blocks," https://www.basicfun.com/knex/, last accessed November, 2022.

22 Schnittka, Christine, "Save the Penguins STEM Teaching Kit," http://webhome.auburn.edu/~cgs0013/ETK/SaveThePenguinsETK.pdf, 2009.

23 ACS, "Mentos and Diet Coke," https://www.acs.org/content/acs/en/education/whatischemistry/adventures-in-chemistry/experiments/mentos-diet-coke.html, last accessed November, 2022.

24 Denton, Nicholas, "Mini Wave Tank Project," 2022 George Mason University Engineers Week student poster competition, February, 2022.

25 Murray, Bonnie, "Drag race to Mars," https://www.nasa.gov/doc/730520main_Drag%20Race%20to%20Mars%20Design%20Challenge.doc, last accessed November, 2022.

26 McCue, L., Hagarty, A., Nowzari, C., Raz, A., Riggi, M., Rosenberg, J., Shishika, D., Smith, C., Nelson, J., "Work-in-Progress: Development of a new hands-on STEM program for biologically inspired maritime robotics," Ocean and Marine Engineering Division, American Society for Engineering Education Annual Conference, Minneapolis, MN, June, 2022.

27 Blue Robotics, "BlueROV2," https://bluerobotics.com/store/rov/bluerov2/, last accessed November, 2022.
28 Mason College of Science, "Aspiring Scientists Summer Internship Program (ASSIP)," https://science.gmu.edu/assip, last accessed November, 2022.