

## Timestamp

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## Nominee Information: Name of Program

Shedd Underwater Robotics

## Nominee Information: Institution

John G Shedd Aquarium

## Nominee Information: Institution Address

1200 S Lake Shore Drive Chicago, IL 60605

## Nominee Information: Telephone of person/people responsible for program

Sadie Norwick: 312.692.3210

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## Nominee Information: AAM Member Number

Sadie Norwick Member ID: 218254

## Please provide documentation on the planning, development, and evolution of the nominated program.

Shedd believes that now more than ever, it is imperative that students connect to animals and the living world, have positive attitudes about science and STEM, feel confident using science skills and know more about ecosystems and the challenges they face. With forethought and to achieve these goals, the aquarium created Shedd Underwater Robotics. In this program, learners are engaged in the 21st century and beyond. They explore technology, conservation, and science education through the innovative engineering of underwater robotics at a time when STEM opportunities are critical to student growth and achievement.

This program is one of many efforts that supports Shedd Aquarium's mission, "At Shedd Aquarium, animals connect you to the living world, inspiring you to make a difference." Robotics allow us and our learning community to explore the environment in new and innovative ways giving us the opportunity to learn about animals, our waters and make changes in ways never known before.

Shedd as well supports a national priority: science, technology, engineering and mathematics (STEM) education. In addition to calling for improved science achievement, educators are emphasizing the cultivation of 21st century learning skills, which include critical thinking, problem-solving and effective oral and written communication. Empowering teachers and students to ideate, design, engineer and use their own remotely operated vehicles (ROVs) has allowed us to do just that.

Launched in fall 2009 with middle school teachers and students (grades six through eight), the Shedd Underwater Robotics program has since expanded. It now offers programming to a larger target audience, welcoming high school students from Chicago Public Schools as well as the broader Chicago area. On average, Shedd helps to form 25-27 underwater robotics clubs each year. In the Club portion of the program, Shedd hosts two teacher professional development training days, online communication and support, resources, curriculum and an annual Club Event that connects all students, teachers, ROVs and field experts.

Furthermore, Shedd Underwater Robotics has grown to annually include the Shedd Midwest ROV Regional MATE completion hosted in partnership with The Marne Advanced Technology Education Center (MATE). During this competition, middle school, high school, and college teams from across the Midwest compete in ROV centered engineering, design, and communication missions.

The continued success and growth of Shedd Underwater Robotics is informed by informal formative assessment continually conducted during all events and annual formal evaluation plans, tools, and reports created in partnership with Shedd Aquarium's Learning Planning and Evaluation team. This evaluation has allowed us to uncover best practices and identify areas to continue to grow the program into the success it is today.

**Please provide an outline of sessions/ one sample lesson plan that will help clarify the program's implementation/our understanding of the program.**

Shedd Underwater Robotics consists of two main program areas: the Club and the Shedd Midwest Regional ROV MATE Competition. In the Competition, teams from around the Midwest compete in ROV engineering missions, panel design discussions and poster presentations to display their skills and knowledge. The competition is hosted in partnership with The Marine Advanced Technology Education Center (MATE). More information about the competition can be found at [www.marinetech.org](http://www.marinetech.org).

The Club portion of Shedd Underwater Robotics consists of two in-person teacher training days, online resources and connections, year-long club support, and a culminating Club Event for teachers and students. All Shedd Underwater Robotics Club materials are open-sourced to program participants enhance learning for teachers and students. They can be found at <https://sheddrov.wikispaces.com/>.

**Please provide an overview of the implementation of the program.**

In order to serve teachers as well as students, Shedd Underwater Robotics Clubs begin with mentorship opportunities and professional development training for the teacher leaders. During two eight-hour professional development sessions, teachers receive all supplies, tools, skills, knowledge, and support needed to engineer and build an underwater robot. This opportunity helps teachers study the basics of marine engineering, including buoyancy, pressure, hydrodynamics, electricity and design, while also learning how to facilitate an underwater robotics unit in an after-school club. Shedd provides teachers with a curriculum written by Shedd program staff in partnership with the Marine Advanced Technology Education Center (MATE) staff and in consultation with field experts. Training is facilitated by Shedd staff.

Shedd mentors teachers to help them, on average, form, run and support 25-27 afterschool

Underwater Robotics Clubs each year engaging a diverse population of teachers and students. Participants are recruited from the Chicago area, with particular emphasis on Chicago Public Schools. The 2015-2016 Underwater Robotics program helped to form ten Underwater Robotics clubs specifically from Chicago Public School. Within these clubs, 85 percent of participants were low-income students, demonstrating that the program provides valuable learning experiences for communities with limited access to resources and in critical need of supplemental STEM education opportunities.

In the after-school clubs, students learn first-hand about underwater science and mechanical and electrical engineering as they work in teams to design and produce a functional ROV. The program culminates with participation in the annual Underwater Robotics Club Event. During the event, which lasts about seven hours and is hosted off-site at a local university natatorium, students and teachers partake in ROV mission challenges, scientific discovery obstacle courses, expert panel sessions, professional ROV driving opportunities, design of ROV attachment solutions, troubleshooting of ROV construction issues, research assistance and more. Students and club leaders also network with other teams, learn about the regional ROV competition, and meet STEM professionals. Students learn how professionals apply critical-thinking and problem-solving skills on a day-to-day basis in their fields of expertise. Interactions with these professionals give students firsthand exposure to a variety of STEM-related careers. At this year's event, hosted on March 19, 2016, 228 students, 63 teachers and 30 volunteers participated.

Shedd Underwater Robotics also hosts the annual Shedd Midwest Regional ROV MATE Competition. The winners of the regional competition continue on to the international competition, held at different locations in North America each year. The regional competition lasts about seven hours and is open to students in grades six through 12 and college. Teams must register for the regional competition in advance, whereupon they receive a mission to complete using their ROV. MATE staff members design and create new missions each year with strong connections to scientific research and exploration. In addition to completing a mission, teams must also present to an engineering panel, describing their ROV design and process. Teams receive points for the verbal defense of their design, a written description and successful completion of the mission. Shedd provides the venue for the event, the judges for the regional competition, support for all teams to compete, and the awards and prizes. On April 30, 2016, 270 students, 54 club leaders, 30 Shedd volunteers, 12 Shedd staff members and more than 100 parents/guests (up from 198 students and 96 club leaders and parents in 2015) took part in the regional competition.

With a tiered approach, Shedd Underwater Robotics provides continued engagement and support for both teachers and students. They can continue to participate in the Underwater Robotics program from year to year, which enables them to refine their skills in developing a device and build on the lessons learned from previous years. It also affords students the chance to further explore their interest in a potential STEM career. In the 2016-17 school year, the program includes 29 Underwater Robotics clubs. Sixteen clubs are first-time participants in the

program. Eight clubs are participating for the second year and five clubs for the third year.

Furthermore, in order to increase the implementation of Underwater Robotics programming with the teen audience, Shedd's new Teen Learning Lab offers additional opportunities for individual teens and clubs to come in and work on their ROVs. This high-tech space, designed by teens for teens, provides a work space and resources such as access to Shedd Staff access to advanced robotics technology. The use of Shedd's Teen Learning Lab has proved to be an effective way to further engage the teen audience in STEM and in underwater robotics.

Overall, Shedd Underwater Robotics engages teachers and students with problem-based tasks that challenge them to think like scientists and engineers. The program also provides professional development opportunities to increase instructors' comfort level in teaching a STEM curriculum and encourage them to actively participate in their students' learning. Teachers are given all the materials and curricula needed to apply and share their learning with students.

## Please provide an overview of the outcomes-intended and actual - of the program.

The specific learner outcomes for Shedd Underwater Robotics are as follows:

- Students will learn the scientific principles of underwater robotics and use STEM processes to create an ROV.
- Students will become familiar with how to use an ROV as a scientific research tool, its real world applications, and how to apply it to solve problems in an aquatic environment.
- Students will be able to utilize and improve upon 21st century skills such as communication, problem solving skills, collaboration and creativity in the development of their ROV.
- Through activities and practice of concepts, teachers will achieve increased comfort and confidence:
  - o Teaching students real-world applications of ROV technologies
  - o Teaching students the scientific principles of underwater robotics and use STEM processes to create an ROV.

## Please provide an explanation/example of the institutional commitment to this program.

Overall, Shedd Underwater Robotics encourages innovation by asking students to work in teams to generate creative solutions to authentic design, scientific, and ecological challenges.

The program sparks curiosity and imagination while also helping participants develop skills such as collaboration, critical thinking and effective oral and written communication. It teaches them how to adapt to new situations, take initiative in groups, and develops STEM skills, knowledge, and career interest.

Shedd has made a long term commitment to the resources dedicated to innovation and STEM programming and will continue to respond to new technologies and incorporate current educational theory, research and evaluation methods. Most importantly, our efforts will continue to support our mission: “At Shedd Aquarium, animals connect you to the living world inspiring you to make a difference”. The precious life that calls our oceans, lakes, rivers and streams home depend on the very next generation of science literate and impassioned individual. And here we start with that one student working with their classmates with PVC pipes and wires, a passion for the natural world, his or her eyes wide with wonder, curiosity and the capacity to be truly, deeply inspired.

With Shedd Aquarium’s aligning mission and support, Shedd Underwater Robotics continues to be a success in not only the Learning Programs Department, but beyond. Scientist in Shedd’s Conservation and Research department have incorporated ROVs and learners into their practices from Great Lakes to the Bahamas. Also, closer to home, aquarists have tapped into the program and the robots to get a better view of habitats such as “Sting Ray Touch.” With the growth and success of Shedd Underwater Robotics, the institution is now getting ready to launch Shedd Aerial Robotics. This new program will utilize the best practices from Shedd Underwater Robotics and apply them to the sky and the next generation of scientific tools and learners.

We sincerely thank you for your review of our application.

## Nominator Information: Name

Heather Schneider

## Nominator Information: Institution

John G. Shedd Aquarium

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## May we contact you with any further questions?

Yes

## Explain the audience-related goals and the museum related goals of the program.

Underwater Robotics exposes students and teachers to STEM topics through the development and application of Remotely Operated Vehicles (ROVs) to investigate aquatic environments and solve ecological and engineering design challenges. By beginning working directly with middle and high school teachers, Shedd experts provide curriculum, training, resources and support that is translated into numerous classrooms impacting hundreds of students each year. Teachers and students then gain firsthand experience applying STEM principles using critical-thinking and problem-solving skills while drawing upon their ingenuity and creativity.

## Please include information on audience response, community/partner relations, as appropriate.

Many distinguished professionals have participated in Shedd Underwater Robotics, sharing their experiences and expertise with both teacher and student participants. One example, Emma Steger, has joined the Club Event for multiple years to share her story as a student a field researcher. In her studies, Emma uses ROVs in Antarctica to explore the feasibility of such devices in extreme environments in collaboration with NASA and the University of Illinois Chicago. Her knowledge and experience provide inspiration to the program participants as well as the following list of other professionals that have participated in the program. We plan for many of these colleagues to join us for the 2017 Club Celebration as well as the 2017 Shedd Midwest MATE ROV Competition.

- Patrick Rowe, founder of Midwest ROV LLC, who shared his application of ROVs for commercial and educational purposes

- Emma Steger, field researcher/student, who shared her application of ROVs in Antarctica to explore the feasibility of such devices in extreme environments in collaboration with NASA and the University of Illinois Chicago
- Chris Olstad from the Marine Resources Development Foundation, whose research laboratory in Florida focuses on telecommunication programs to bring virtual communication to organizations, including ROVs to explore underwater environments
- Stuart Lynn and Arfon Smith, both from Zooniverse, an online center for citizen science projects
- Kevin Lynch, professor of engineering at Northwestern University
- Rob Paddock, ROV pilot for the Great Lakes WATER Institute at the University of Wisconsin, Milwaukee
- Purdue University's underwater robotics team
- Jarrett Meltzer, former oceaneering ROV pilot and current Shedd volunteer
- Mark Gleason, Assistant Faculty, Department of Hospitality and Tourism Management, Grand Valley State University, Grand Rapids, Michigan
- Guy A. Meadows, PhD, director of Great Lakes Research Center and Robbins Professor of Sustainable, Marine Engineering at Michigan Technological University
- Caitlin Meadows, graduate student of geophysical sciences at University of Chicago

Not only has Shedd Underwater Robotics involved such a wide range of experts, the program has also been shared and discussed in many venues. Over the past year and a half, we presented information about Shedd Underwater Robotics for the following audiences and events:

- Aquatic Education Group (AEG) Board
- Middle and high school students from City Year
- High school students at Gary Comer Youth Center's Upward Bound Program
- Northeastern Illinois University's GEAR Up Program
- Noble Charter Network's Annual STEM Expo
- Chicago Ideas Week YOU(th) Kick-off Event
- Brookfield Zoo's Teen Summit

Additionally, Shedd Aquarium staff will be presenting the program at the National Science Teacher Association annual conference in 2017.

Lastly, we have provided a list of media activity featuring the 2015-16 ROV program below:

- Shedd's Learning Twitter:
  - 📎 @SheddLearning
  - 📎 #SheddROV
- The Times of Northwestern Indiana article on October 11: Robotics is the rage thanks to innovative teacher
- Chicago Tribune article in the Wilmette Life section of the January 4 issue: St. Francis students gain skills while creating underwater robot
- Team videos by Robotics Crusaders, a Shedd ROV Club: Br. Rice Robotics on Twitter
- Shedd's January Teacher Professional Development Storify: Teacher Workshop for



## #SheddROV

- DNA Chicago story: Meet Brother Rice High School's Underwater Robot, Edmund MK 2.5
- Shedd's Storify of ROV Club Celebration: Shedd Aquarium ROV Club Event 2016
- Rockford Register Star article: RPS 2015 students build underwater remote vehicle in Shedd program
- Shedd's Storify of the 2016 Shedd Midwest MATE ROV Competition: Shedd Aquarium ROV Regional Competition 2016
- Patch.com article: Team Vector Advances to International Competition
- Underwater Robotics Program

## Explain evaluation process, data collection, and results of the evaluation (can include front-end, formative, and summative evaluation).

Shedd Aquarium is proud to be home of The Learning Planning and Evaluation Department--one of the first of its kind in an aquarium setting which is dedicated to bridging research to practice, building staff evaluation capacity, and conducting program evaluation. This department conducts literature reviews for current trends and best practices to continuously improve the effectiveness of Shedd's learning experiences. The Learning Planning and Evaluation Department, in conjunction with the Learning Programs Department, evaluates all of Shedd's programs to determine if they are accomplishing goals, learner outcomes, and advancing the institution's conservation-focused mission. Through this partnership, analysis of evaluation data indicates that the Underwater Robotics Program was successful in meeting program goals and outcomes for years.

Most recently, evaluation revealed that the 2015-16 Underwater Robotics program was also successful in meeting its stated goals and outcomes as evidenced through teacher and student evaluations. Data taken from post-program reflective student surveys showed that student assessment of their ability to use science, technology, engineering and math to build an ROV improved significantly, with 43 percent indicating limited to neutral ability before participating in the program and 75 percent indicating a strong ability at the end of the program. Furthermore, the student post-program survey captured the following percentages of students who stated that they used the listed skills some, most or all of the time:

- Critical thinking skills: 96%
- Creating solutions to problems: 97%
- Creativity: 97%
- Communication and collaboration: 96%
- Technology skills: 95%

- Flexibility: 94%
- Hard work: 96%
- Leadership and responsibility: 96%

Due to successes like these, interest in the program has been consistently high. For the past four year the Underwater Robotics clubs and MATE competition were filled to capacity. Another sign of success was the return of groups and teachers from previous years. For instance, a teacher formerly at Eli Whitney School and now teaching at Langston Hughes Elementary successfully completed her seventh year in the program. This year, many teams found innovative solutions to problems. The club from Brother Rice High School, for instance, continued to incorporate an Arduino chip and also advanced its ROV design and capabilities by including a hydraulic system that operated a rotating arm attachment. Intra and inter-team collaboration was another theme in 2015-16. Through dedication and communication, Rauner College Prep, a Shedd ROV Club, demonstrated the benefits of teamwork when the club addressed multiple safety violations in less than 30 minutes at the Shedd Midwest MATE Regional ROV Competition. The Science Chicks, another Shedd club, gained the support of fellow teams by disseminating buttons bearing their self-designed logo.

- The following quotes further demonstrate the program's positive impact:
- "The Underwater Robotics Program helps to provide insight in problem solving and thinking creatively." (Student)
- "This program is a wonderful way of discovering a new form of science and engineering that is difficult to find in a classroom setting." (Student)
- "This program has been very helpful in applying my knowledge and skills in real world situations. If I wasn't a senior, I would participate in this program next year." (Student)
- "All of them had no idea about ROVs before and now many are looking if the college they are going to has a robotics club." (Teacher)
- "They came up with their own solutions to problems they encountered while designing the ROV." (Teacher)

During the 2016-17 school year, Shedd Underwater Robotics programming will serve 29 clubs. These clubs will include Chicagoland high schools and middle schools. In addition, Shedd's Teen Learning Lab will continue to support Underwater Robotics. An innovative space developed by teens for teens, the Lab is a hub for students to meet other science-minded friends and peers and access a variety of up-to-date technology. This year, the Teen Learning Lab will host a series of Underwater Robotics drop-in activities utilizing the same resources as clubs, as well as more advanced options, including Arduinos.

Evaluation will continue to play an important role in the Shedd Underwater Robotics allowing us to refine best practices and provide the best possible experience for our learners.

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I grant permission for EdCom to share this entry/nomination in printed/digital format with the Museum Education Community

## Person/people responsible for Program

Program Facilitators: Belle Archaphorn, Alyssa Firkus, Sabrina Bainbridge Program Manager:  
Sadie Norwick Program Assistant Director: Heather Schneider Program Director:  
Samantha Norton