

2016 ANNUAL REPORT



From the Director

Happy 2017 to all.

I begin by extending a sincere thanks to all of you who donated effort and/or funds during 2016 to the Woods Hole Oceanographic Institution's Office for Technology Transfer. For others interested in becoming involved, you'll find information later in this report on becoming a friend of WHOI OTT.

I am pleased to report that the dynamic growth and development of Technology Transfer at WHOI reported in previous years, continued throughout 2016. The buzz phrase of this past year was proof of concept funding. The phrase refers specifically to the development of commercial prototypes suitable for obtaining proof of concept data. Last year, WHOI made its greatest single year investment in commercial prototype development of approximately \$170,000. \$120,000 of this was a direct result of the awards made to the three winning teams of the Shark Tank competition at the close of 2015. Another \$50,000 was awarded to WHOI entrepreneurs through an OTT fund for the development of products with expressed outside commercial interest. These awards led both to considerable project advancement, and to new inbound company inquiries regarding the on-call lobster trap, AutoBOD technology (for wastewater treatment and ocean research), and MIME wind turbine sensor technology.

Licensee lead generation was another positive development for the department in 2016. Complementing the plain old-fashioned phone call, our new logo, website, print and social media presence have led to increased queries and follow-ups generating many new licensing leads. In 2017, we will implement new metrics to track the lead-generating success of our marketing efforts.

Our outreach to Champions and Mentors through local presentations, social media and the website has given us a stable of more than thirty potential volunteers from the local community.

Looking forward to 2017, in addition to our continuing efforts to find resources to support proof of concept activities, we intend to improve our capabilities in market research in order to prioritize department efforts to identify, patent, and market WHOI's top technologies.



8

Issued Patents



170k+

In Proof of Concept Funding



30+

Registered Tech Mentors & Champions



Have a great 2017.

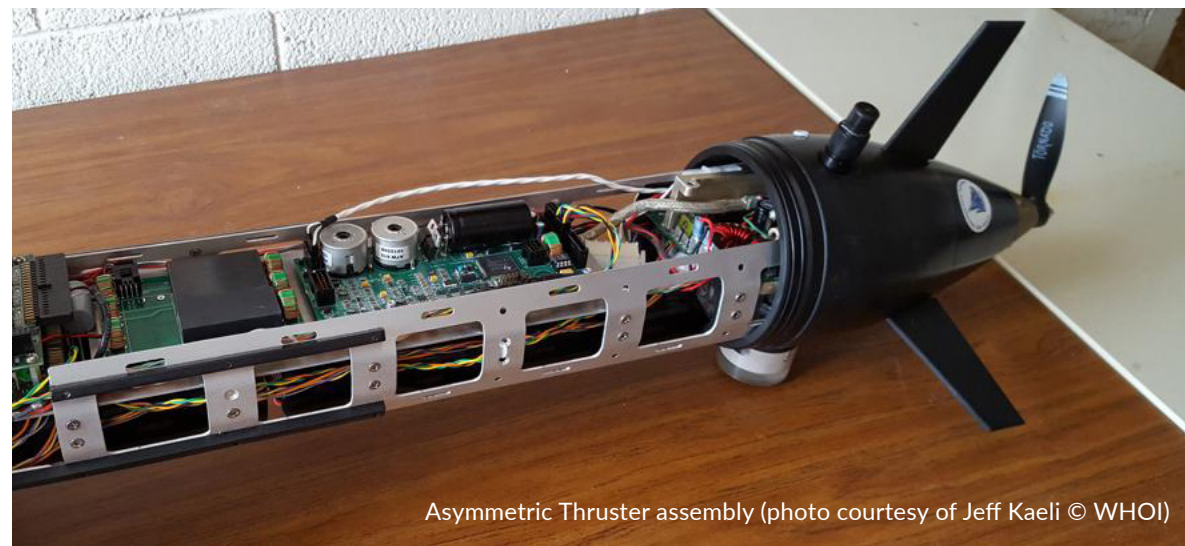
David Knaack,
Director for Technology Transfer

2016 Shark Tank Awardee

In its second annual Shark Tank competition, The Office for Technology Transfer awarded Jeff Kaeli & team \$75,000 towards the advancement of the Asymmetric Thruster.

The technology combines propulsion and maneuverability in a single blade and could be of interest to many industries for its potential to navigate at low speeds, as well as hover. The review panel included Board of Trustees member Edmund Woollen, Honorary Corporation member George Chamillard, and Director of Research Larry Madin. The recipients will be required to use the award money to meet a series of milestones over the coming year.

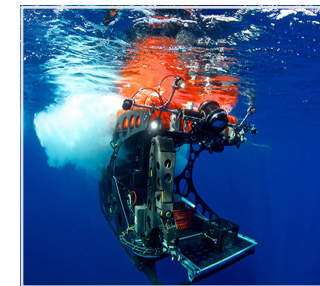
The Shark Tank is held annually every September. Applicants are required to make a pitch presentation for a panel of judges. In 2017, OTT will be revising the Shark Tank Process to include the help of Mentors in creating and refining inventors' presentations. Learn more about the Asymmetric Thruster here: <http://bit.ly/2iO7DXN>



Asymmetric Thruster assembly (photo courtesy of Jeff Kaeli © WHOI)

OTT In The News - 2016

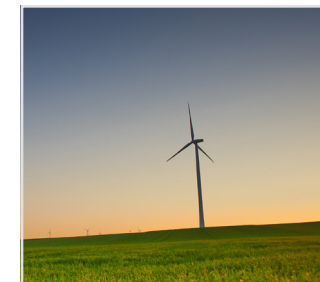
In 2016, The Office for Technology Transfer introduced its editorial initiative with the goal of bringing media attention to WHOI innovations. Several WHOI technologies were featured in both major news publications and industry magazines throughout the past year, generating interest from potential licensees. In 2017 we plan to grow this initiative in support of licensing efforts. Below is a selection of articles from throughout the past year:



Ocean News & Technology Nereid HT

In August 2016, a new hybrid Remotely Operated Vehicle (ROV)/Autonomous Underwater Vehicle (AUV) robot from Woods Hole Oceanographic Institution (WHOI) was sea trialed in Panama to 2,500m. The trials and technology, Nereid HT, are featured in the November issue of Ocean News & Technology.

Read More: <http://bit.ly/2iO6e3s>



Windpower Engineering WHOI Introduces Innovative Wind Turbine Monitor

WHOI announced the issuance of US Patent No. 9,395,338 for its self-regulating terrestrial turbine control, which is done through environmental sensing. The Multimodal Environmental Impact Monitor (MIME) developed by WHOI uses an all-in-one sensor package that measures flicker, acoustic noise, and vibration generated by wind turbines.

Read More: <http://bit.ly/2jQ1o7w>



Oceanus Whale Safe Fishing Gear & New Device Reveals What Ocean Microbes Do

Oceanus featured articles in 2016 on an innovative Ropeless Lobster Trap as well as Phorcys, an automated instrument that can rapidly measure microbial photosynthesis and respiration in the ocean and send data back to scientists in near real time.

Read More: <http://bit.ly/2faucld>



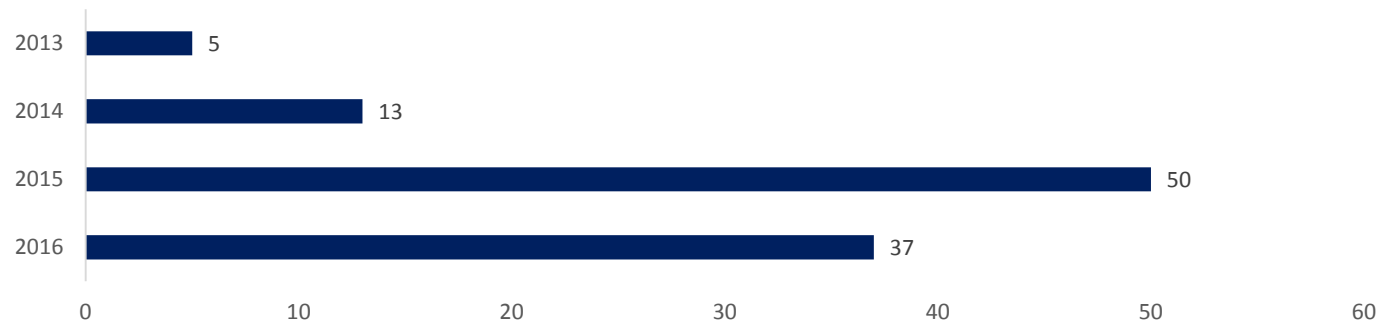
The Atlantic A Robot Buoy That Saves Whales From Boat Strikes

A buoy using EOM stretch hose technology in collaboration with WCS is being used off the coast of New York to help prevent whale strikes in busy shipping lanes.

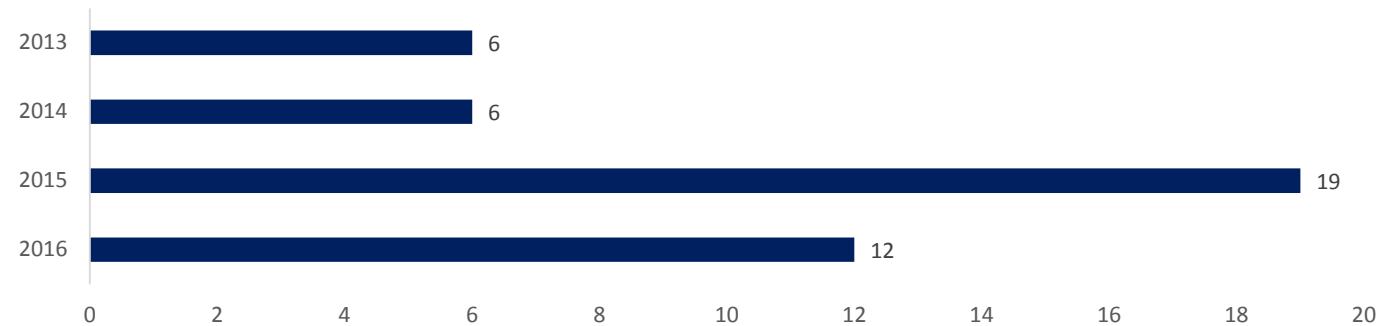
Read More: <http://theatlantic.com/2aZ66tX>

Patent Metrics

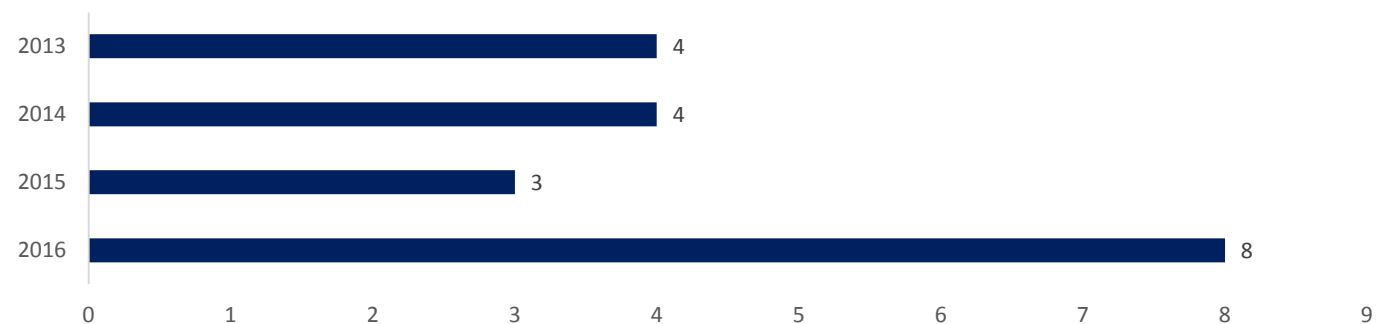
Disclosures 2013-2016



U.S. Patent Filings 2013-2016



Issued Patents 2013-2016



2016 Issued Patents

1. Patent No. 9,231,708 "Optical Communication Systems and Methods" Inventors: Norman E. Farr, Jonathan Ware, Clifford T. Pontbriand
2. Patent No. 9,234,012 "Cobalamin Acquisition Protein" Inventors: Makoto Saito, Erin Marie Bertrand
3. Patent No. 9,235,048 "Marine Environment Antifouling System and Methods" Inventors: Norman Erwin Farr, Clifford Thomas Pontbriand, Timothy Goodwin Peters
4. Patent No. 9,294,201 "Optical Communication Systems and Methods" Inventors: Norman E. Farr, Lee Freitag, James Preisig, Dana Yoerger, Sheri N. White, Alan D. Chave
5. Patent No. 9,395,338 "Sensor System for Environmental Impact Monitoring" Inventors: Paul Dominic Fucile, Glenn Elwin McDonald, Edward Leo Hobart
6. Patent No. 9,394,174 "Alkyne-Assisted Nanostructure Growth" Inventors: Desiree L. Plata, Philip M. Gschwend, Anastasios John Hart, Eric R. Meshot, Christopher M. Reddy
7. Patent No. 9,441,947 "N-Wavelength Interrogation Scheme for Low Coherence Interferometers" Inventors: Jason A. Kapit, Norman E. Farr, Raymond W. Schmitt
8. Patent No. 9,463,849 "Mechanical Tether System for Submersible Vehicle" Inventors: Robert McCabe, Andrew Bowen, Matthew Heintz



FIG. 1B

2016 Provisional Patent Filings

1. Provisional Patent Application No. 62/339,157 "Ropeless Fishing Gear System" Inventors: Jim Partan, Keenan Ball
2. Provisional Patent Application No. 62/428,204 "Benchtop Aquatic Analysis System" Inventors: Ben Van Mooy, Paul Fucile, Glenn McDonald
3. Provisional Patent Application No. 62/340,743 "Improved Methane Sensor" Inventors: Anna Michel, John Bailey
4. Provisional Patent Application No. 62/293,368 "Soft-Bodied Eco Sensor Tag" Inventors: Terrence Aran Mooney, Kakani Katija, Kenneth Alex Shorter
5. Provisional Patent Application No. 62/307,849 "Autonomous Underwater Vehicle Sampler System" Inventors: Annette Govindarajan, Jesus Pineda, Michael Purcell, John Breier
6. Provisional Patent Application No. 62/395,538 "Marine Animal Tracking Autonomous Vehicle" Inventors: Amy Kukulya, Thomas Austin, Frederic Jaffre
7. Provisional Patent Application No. 62/345,175 "Oxidative Stress Biomarker Software" Inventors: James Collins, Ben Van Mooy
8. Provisional Patent Application No. 62/419,112 "Small Molecule Growth Inhibitors Of Microbial Pathogens" Inventor: Tracy Mincer

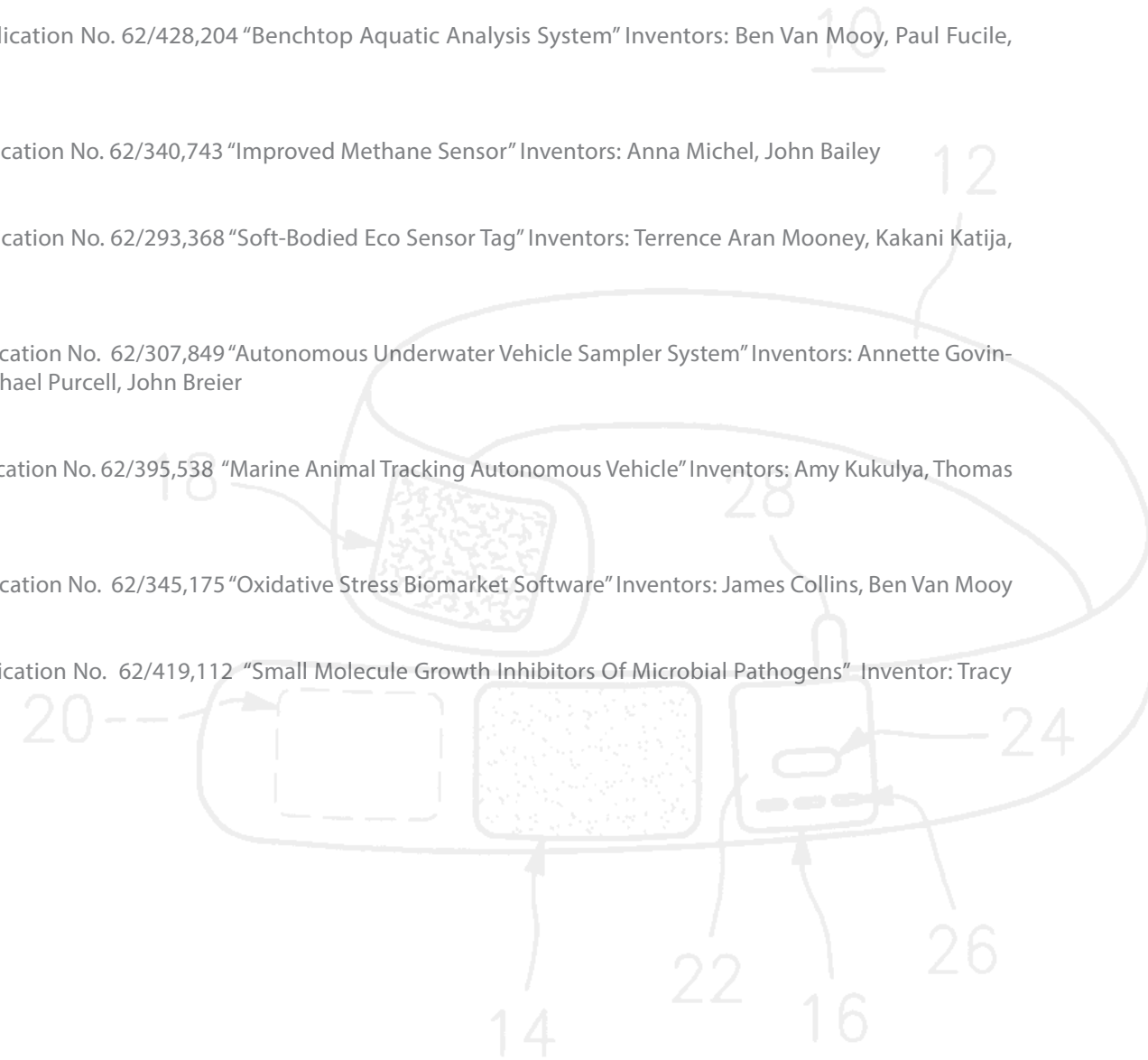


FIG 1

2016 U.S Patent Filings

1. Patent Application No. PCT/US16/55159 "Articulating Moored Profiler System" Inventors: John Toole, Kenneth Doherty, Jeffrey O'Brien, Fredrik Thwaites
2. Patent Application No. PCT/US16/57160 "Compositions and Methods for Absolute Quantification of Proteins" Inventors: Mak Saito
3. Patent Application No. PCT/US16/45466 "Compact Winch Apparatus" Inventors: James Haley, Josh Eaton
4. Patent Application No. 15/009,991 "System for the Deployment of Marine Payloads" Inventors: Tom Austin, Frederic Jaffre, Robin Littlefield, Gwyneth Packard, Mike Purcell, Glenn McDonald
5. Patent Application No. PCT/US16/44061 "Aquatic Sampler and Collection Apparatus" Inventors: Carl Kaiser, Andrew Billings
6. Patent Application No. PCT/US16/57006 "Early Algal Bloom Detection By Raman Spectroscopy" Inventors: Scott Gallager Austin, Frederic Jaffre
7. Patent Application No. US20150140619 "Use of marine algae for co-producing alkenones, alkenone derivatives, and co-products" Inventors: Gregory O'Neil, Chris Reddy
8. Patent Application No. 15/040,008 "Turbine Sensor System for Environmental Impact Monitoring" Inventors: Paul Fucil, Glenn McDonald, Edward Hobart
9. Patent Application No. 15/227,253 "Submersible Interferometric Sensor System" Inventors: Jason Kapit, Ray Schmitt, Norm Farr
10. Patent Application No. 15/120,519 "Improved-Efficiency Submersible Thruster" Inventors: Carl Kaiser, Andy Billings
11. Patent Application No. 15/261,086 "Mechanical Tether System for a Submersible Vehicle" Inventors: Robert McCabe, Andrew Bowen, Matthew Heintz
12. Patent Application No. 15/306,100 "Environmental Monitoring Assembly and Method" Inventor: Ken Buessler

Coastal Integrated Solutions

In 2016, a startup called Coastal Integrated Solutions was formed around the WHOI technology Jetyak, a new autonomous surface vehicle (ASV).

Coastal Integrated Solutions was started by WHOI engineers Peter Traykovski, Hanumant Singh, and Kevin Manganini and grew from an innovative ASV created here, at WHOI.

The team recently took part in a workshop through the Alliance for Coastal Technologies, a partnership of organizations that promotes the development of reliable sensors and platforms. These workshops provide a status of current technologies and a place to discuss opportunities for advancement.

This workshop titled *Autonomous Surface Vehicles*



Photo courtesy of Rocky Geyer © Woods Hole Oceanographic Institution

(ASVs) for Shallow Water Mapping and Water Quality Monitoring took place at the University of Maryland's Chesapeake Biological Laboratory and aimed to foster the evolution of ASVs from research tools to operational tools.

In a series of field demonstrations throughout the workshop, the Jetyak ASV executed several top performances and provided the team with feedback regarding potential improvements, and industry needs - a valuable knowledge base to start Coastal Integrated Solutions.

The core of this technology, Jetyak, is an OEM, gas-powered kayak. Its rugged design features a roto-molded polyethylene hull and an air-cooled seven

horsepower, four stroke engine. It is propelled and steered by water drive, excluding propellers and dangerous parts, making it ideal for surface studies without risk to marine wildlife.

The stock boat is about eleven feet in length and weighs about 165 pounds. It's capable of running for eight to ten hours on three gallons of gas at survey speeds of two to six knots. The innovative ASV is able to map and measure water that's too shallow or turbulent for underwater vehicles and can be used for repetitive surveys performed more precisely by autonomous systems. Its speed and stability allow it to operate easily in strong wind or currents.

The team envisions customers from within the research community and potentially industries such as oil and gas, fisheries management, and hydrographic survey, among others.

The Jetyak is highly customizable and will be made to order, including unique sensors and set-ups for specific applications & customers.

More information on the company will be made available on the WHOI OTT website as the company continues to grow and evolve.



ASV Jetyak at the mouth of West Greenland's Sarqardliup Glacier.

Photo courtesy of Fiamma Straneo © Woods Hole Oceanographic Institution

Hydroid: A Flourishing Partnership

In 2016, Hydroid unveiled its New Generation REMUS 100, designed in partnership with WHOI.

Hydroid, a Massachusetts based WHOI spinoff, manufactures autonomous underwater vehicles (AUVs) called REMUS (Remote Environmental Measuring Units) and also supplies AUVs and related sensors/accessories. The company designs and manufactures state-of-the-art solutions for use in a number of applications including marine research, commercial and defense. It was established in 2001 by REMUS AUV inventor, Chris Von Alt, and acquired by Kongsberg in 2008. Since then, Hydroid has been a leader in the field of marine robotics, all while maintaining a close working relationship with both WHOI as well as the United States Navy.

REMUS vehicles and innovations are developed through the The Ocean Systems Laboratory (OSL) at WHOI - a team of engineers, technicians and staff led by Mike Purcell, conceptualizing and building AUVs. OSL started with a small 100 meter depth-rated two person portable vehicle just over a decade ago, and now builds larger, more powerful vehicles rated for depths up to 6,000 meters. OSL aims to provide the latest cutting-edge AUV technology for use in both research and military applications.

So what is a REMUS? REMUS are small, low-cost AUVs, usually weighing under 80lbs. They consist of an array of

sensors customized for each use- making them an extremely versatile tool. Their size and weight make them ideal for launch & recovery and their user-friendly platform allow for use by non-technical personnel.

The OSL Hydroid partnership resulted in the creation and release of the New Generation REMUS 100 in 2016. The New Generation REMUS 100 is built on the trusted technology of the original REMUS 100, but features advanced technology and capabilities, the first of their kind in the industry, including design upgrades in the form of a flexible navigation suite, high capacity battery pack, and advanced core electronics, among others.

In Hydroid's [press release](#) regarding the new REMUS, Duane Fotheringham, president of Hydroid says, "the New Generation REMUS 100 AUV has impressive capabilities not previously seen on a man-portable vehicle. We are confident that we have created a vehicle that fulfills our customers' needs for leading technology, while maintaining the core offerings of the REMUS brand they have trusted for years. Thanks to the New Generation REMUS 100, we are continuing to pave the way for future unmanned underwater technology."



OSL and Hydroid produce two other vehicles, the REMUS 600 and the REMUS 6000, both designed for greater depth rating and payload capacity. The REMUS 600 is described as full capability in a cost effective system. It's the most versatile of the REMUS vehicles with the ability to hold a large payload and run for up to 45 hours. The REMUS 6000 is described by Hydroid as a deepwater workhorse. It's the largest of the three vehicles with a 6,000m depth rating and up to 22 hours mission duration.

More Information on Hydroid & the New Generation REMUS 100 can be found on their website: www.hydroid.com

Website Launch

In 2016, WHOI launched it's new website aimed at increasing licensing opportunities for WHOI technologies.

The site is designed for easy navigation and access to information for WHOI Scientists/Engineers, members of industry, or potential volunteers.

The Inventor's Portal was created in part to promote transparency in the technology transfer process. Here, WHOI Scientists and Engineers can find information on the patent process, business resources, links to funding opportunities, the WHOI IP Policy, and an online invention disclosure form. It provides step-by-step information on how WHOI technologies are

evaluated as well as answers to frequently asked questions.

Also in the theme of transparency, is our News & Events section where we post upcoming events, editorial features, and tech updates. Previous newsletters & annual reports are made available to view on this page.

Entrepreneurs can now learn more about the Tech Mentors and Champions Program and register online under "Get Involved" - enabling OTT to build a network of qualified volunteers interested in helping WHOI technologies get off the ground. As this program expands, additional opportunities may become available via the website.

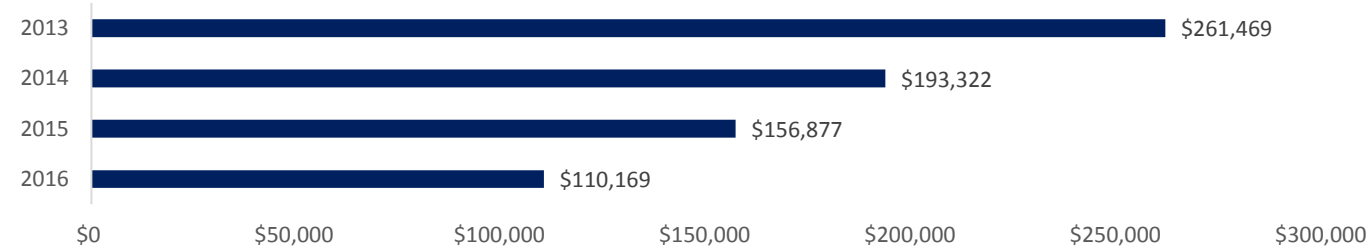
Perhaps the most important feature of the new site is the "Licensing Opportunities" section where WHOI technologies available for licensing are described. These technologies are also listed and linked through several technology networking sites. Interested industry visitors are able to download additional technology information and easily contact the office from within each technology listing.

Upgrading the website will be an ongoing project, it will be improved annually with feedback from the user-community. We are hoping this resource proves useful to WHOI Inventors and its focus on increasing the visibility of WHOI technologies results in favorable licensing outcomes.

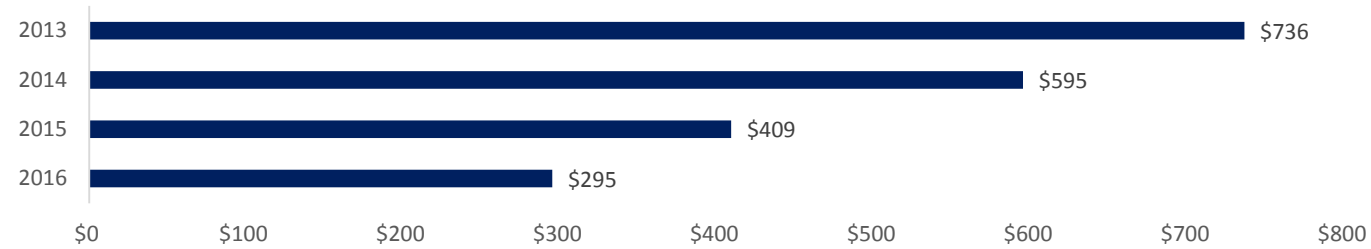
By The Numbers

Expense & Income Report

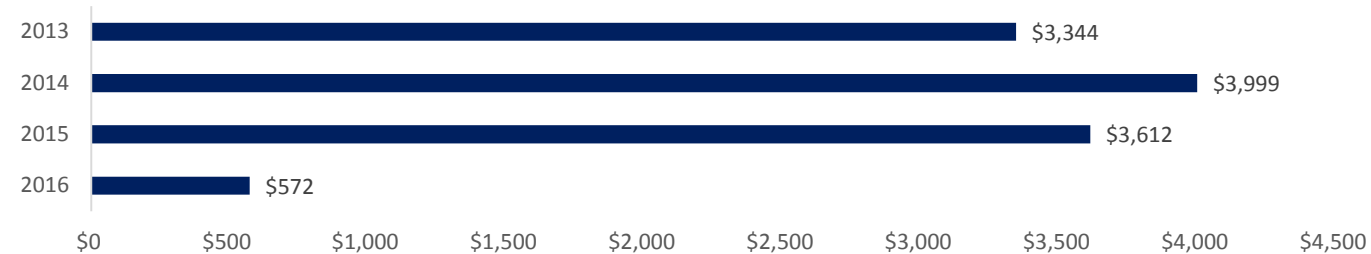
Total Active Case Costs



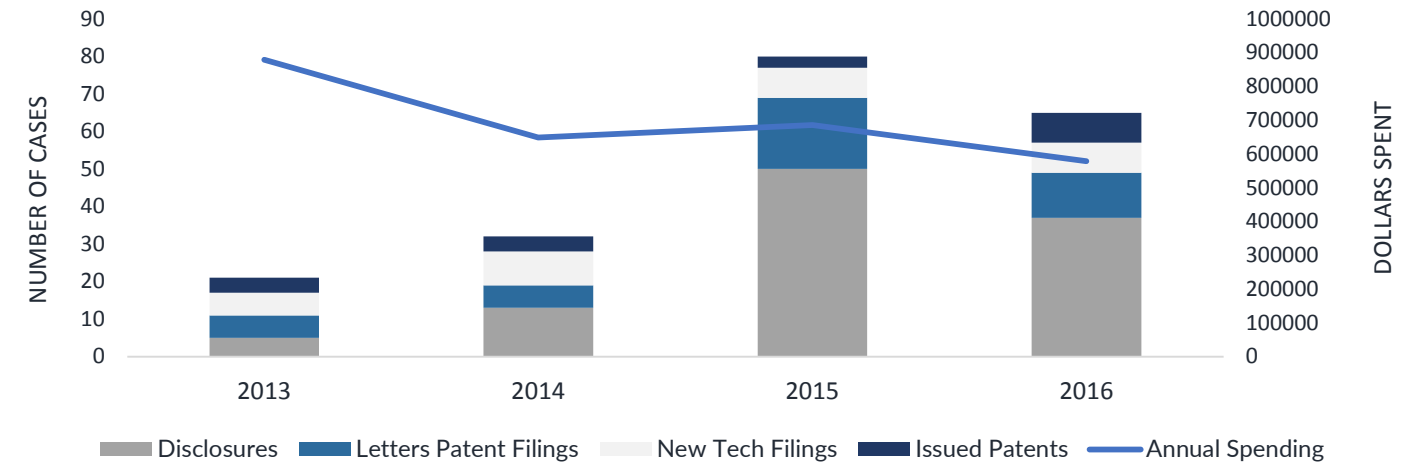
Average Cost Per Pending Case Per Month



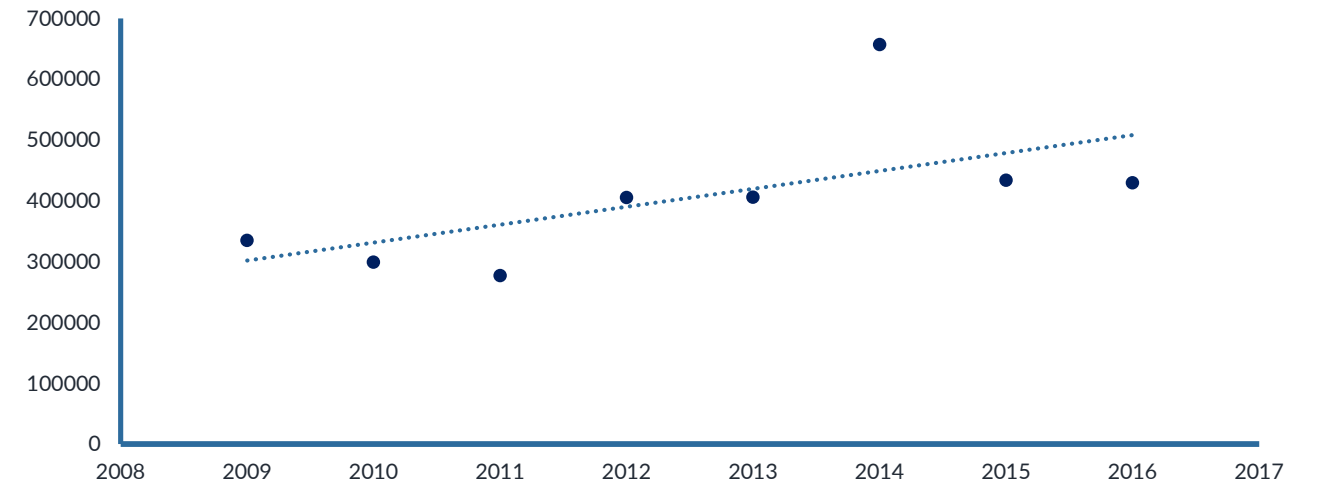
Average Cost Per New Filing



Overall Patent Activity Compared to Departmental Spending 2013-2016



Royalties by Year



Partnering & Outreach

In 2016, OTT performed outreach through several local groups including the Cape Cod Technology Council (CCTC), SCORE, Cape Cod Commission, and Cape Cod Chamber of Commerce to name a few, as well as via select events and meetings.

Some of these partnerships resulted in the growth of the Tech Mentors and Champions Program, a 2016 initiative to build a network of entrepreneurs as a resource for WHOI inventors. With 30+ registrations in its first year, the program should continue to grow in 2017, offering more opportunities for involvement for registrants.

Other notable community events in 2016 included the June visit of Massachusetts Governor Charlie Baker and Representative Bill Keating for a blue economy briefing and technology showcase.

Two WHOI Tech Transfer Translational Research Fund awardee teams took part in the showcase: Ben Vay Mooy, Paul Fucile, and Glenn McDonald's AutoBOD Real-Time Biological Oxygen Demand Sensor and Jim Partan and Keenan Ball's On-Call Lobster Buoy Technology. Both groups had the opportunity to discuss their technologies with Governor Baker and Representative Keating.


***Woods Hole stands as the Silicon
Valley of Marine Science.
- Governor Charlie Baker***

The Cape Cod Chamber of Commerce along with Coastal Community Capital helped WHOI to Sponsor another key event in 2016, Startup Weekend Blue. The event took place in April at WHOI's Quissett Campus and aimed to start new companies targeting the largest opportunities presented by the Blue Economy.

Startup Weekend is a global organization hosting 54-hour weekend events, during which groups of entrepreneurs pitch ideas for new startup companies, form teams around those ideas, and work to develop a working prototype, demo, or presentation by Sunday evening. About twenty-five entrepreneurs and ten coaches participated in the event with about fifty attendees. The event will serve as a jump-off point for a unique Startup Weekend set to take place in 2017 aimed at getting select WHOI technologies off the ground.

*WHOI Engineer & MIME
Inventor Paul Fucile speaks with
Representative Bill Keating during
the technology showcase in June*

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