

17th Annual

MANNED

UNDERWATER VEHICLES

SYMPOSIUM

2020



Underwater Intervention, February 4-6, New Orleans, LA USA

# 2020 MTS MUV SYMPOSIUM

## Technical Program Schedule

**TUESDAY FEB-4-2020 HALL E - ROOM 345**

No	Session	Speaker	Company	Presentation Title
1	8:30 - 9:00	<b>Will Kohnen</b>	Hydrospace Group Inc	Overview of Global Manned Submersible Industry Activity in 2019/2020
2	9:00 to 9:30			
3	9:30 to 10:00	<b>Andy Whitman</b> <b>Bruce Stickrott</b>	WHOI	DSV Alvin 2019 operations summary and scheduled 6500m upgrade
4	10:00 to 10:30	COFFEE BREAK		
5	10:30 to 11:00			
6	11:00 to 11:30	<b>Patrick Lahey</b>	Triton Submarines	The Triton 36,000/2: Building the world's most extreme ocean exploration tool
7	11:30 to 12:00	<b>Sarah Frias-Torres</b>	Vulcan Inc.	Subsea Innovation Needs for Reef Restoration: From Shallow to Deep Sea Corals
8	12:00 to 12:30	<b>Charles Kohnen</b>	SEAmagine Hydrospace Corp	SEAmagine AURORA submersible design features after 25 year's development
9	12:30 to 1:00	LUNCH		
10	1:00 to 1:30	<b>Philip L. Hoffman</b> <b>NOAA OER</b>	<i>Main Exhibit Floor</i> <i>Supplier Solutions Theater</i>	<b>KEYNOTE - NOAA Support for the 21st Century Blue Economy</b>
11	1:30 to 2:15	<b>Manned Systems Group</b>	<i>Supplier Solutions Theater</i>	<b>Film Festival</b> <b>Series of Short Videos from the MUV industry in 2019</b>
12	2:15 to 2:30			
13	2:30 to 3:00	<b>Kirsten &amp; Joachim Jakobsen</b>	Rebokoff-Niggeler Foundation	The LULA1000 - a reliable tool for deepsea quality filming and research
14	3:00 to 3:30	<b>Pere Fores</b>	Ictineu Submarins SL	2019 ICTINEU 3 exploration of the Canary Islands continental slope
15	3:30 to 4:00	<b>Chris Welsh</b>	Deep Sub/DeepFlight LLC	DeepFlight Operations & Plans 2019/2020
16	4:00 to 4:30	VISIT SHOW FLOOR		
17	4:30 to 5:00			
18	5:00 to 7:00	<i>MTS MUV</i>	<i>MUV Cocktail Reception</i>	HAMPTON Inn Hotel

**WEDNESDAY FEB-5-2019****HALL E - ROOM 345**

No	Session	Speaker	Company	Presentation Title
1	8:30 - 9:00	<b>Roy Thomas</b>	ABS ANNUAL Industry Meeting	Overview of ABS Underwater Rule Change Proposals for 2020
2	9:00 to 9:30			
3	9:30 to 10:00	<b>Leonard Pool Rubin Sheldon</b>	SIDUS Solutions Inc	Underwater Vehicle Video Requirements
4	10:00 to 10:30	COFFEE BREAK		
5	10:30 to 11:00			
6	11:00 to 11:30	<b>Cpt Robert Wolf</b>	US NAVY - NAVSEA PMS391	US Navy Submarine Rescue Systems TUP Certification and New Capabilities
7	11:30 to 12:00	<b>Cpt Robert Wolf, US NAVY Mark Schleef, US Navy DSU Matthew Wehner, Phoenix Int'l Dan Zatezalo, Sonardyne Ben Kinnaman, Greensea Rico Castelo, Rowe Tech</b>	US Navy	PANEL DISCUSSION: Underwater submersible tracking & navigation from vessels of Opportunity under harsh operating conditions
8	12:00 to 12:30			
9	12:30 to 1:00	LUNCH		
10	1:00 to 1:45	<b>Unmanned Systems Group</b>	Main Exhibit Floor Supplier Solutions Theater	Ocean Infinity New Product Announcement Film Festival - Unmanned Systems Short Videos from industry in 2019
11	1:45 to 2:00			
12	2:00 to 2:30	<b>Alec Smyth</b>	Innerspace Science	Citizen Submariners
13	2:30 to 3:00	<b>Dana Wilkes</b>	NOAA	Overview of research operations with manned submersibles
14	3:00 to 3:15			
14	3:15 to 3:30	<b>Kip Peterson</b>	Thorsborg LLC	Overview of Marine Incidents 2019
15	3:30 to 4:00	<b>Gard Clark</b>	MTS MUV Workgroup	WORKSHOP: MUV Operations Consensus Standard
16	4:00 to 4:30			
17	4:30 to 5:15	<b>Will Kohnen</b>	MTS MUV Cmtee	ANNUAL COMMITTEE MEETING
18	5:15 to 5:30	VISIT SHOW FLOOR		

**THURSDAY FEB-6-2019****HALL E - ROOM 345**

No	Session	Speaker	Company	Presentation Title
1	8:30 - 9:00	<b>Jarl Stromer Wolfgang Stuber Jakob Sixl</b>	Triton Submarines Roehm GmbH Heinz Fritz GmbH	60 Years History in Manufacture of Acrylic windows for Deep Submersibles
2	9:00 to 9:30	<b>Guy Richards</b>	Blanson Ltd	Aftercare and Inspection of Acrylic Windows
3	9:30 to 10:00	<b>Lynda Estes Hannah Bradley</b>	NASA Johnson Space Center	Spacecraft Window Environmental Considerations and Design Evolution
4	10:00 to 10:30	COFFEE BREAK		
5	10:30 to 11:00	<b>Bart Kemper Krista Kemper</b>	Kemper Engineering	Debarcation Syndrome and Commercial Submarines
6	11:00 to 11:30	<b>Steve Smith</b>	PROTEK Models	Additive Manufacturing and 3D Printing for Manned Underwater Vehicles
7	11:30 to 12:00	<b>Jess Totten</b>	ABS	ABS on Additive Manufacturing for Manned Submersibles
8	12:00 to 12:30	<b>Carne Parareda</b>	Ictineu Submarins SL	Full ocean depth pressure-tolerant LiPo batteries Capabilities & Performance



Dear Members and Attendees,

It is a great pleasure to welcome you again to UI2020, host of our 17<sup>th</sup> Annual MUV Symposium sponsored by the Marine Technology Society committee on Manned Underwater Vehicles. Once again, the industry from around the world gathers in New Orleans to unite manufacturers, operators and pilots, and support service providers who thrive in the intersection of engineering, technology advancements and the spirit of subsea innovation.

This year, the world celebrates the 60th anniversary of the first TRIESTE dive to the Mariana Trench, and the 50th anniversary of Apollo 11 and NASA's manned exploration of the Moon, both significant milestones in human exploration. We extend a special welcome to engineers from NASA Johnson Space Center, to discuss the design and qualification process NASA uses for their spacecraft windows, an equally special element in all MUV designs.

I wish to highlight our own industry advances in the program, which include:

- ) A historic dive expedition to the five deepest points of the oceans, 60 years after Trieste
- ) Keynote from NOAA OER on the vision for the next 10 years as part of the Blue Economy
- ) A Mini Film Festival on the Exhibition floor showing the MUV industry activity in 2019
- ) An award ceremony to a Pioneer in the MUV industry for 60 years, during the reception
- ) A Panel discussion with the US NAVY on underwater tracking systems

The Symposium has 34 speakers with 24 interesting presentations over the three days. These feature Deep Ocean Expeditions, tourism and commercial vehicle operations; advances in subsea technology, batteries, acrylic windows, underwater navigation, as well as regulatory developments in design, testing and operation of MUVs.

Join us Tuesday evening for a special award ceremony at our MUV Cocktail Reception at the Hampton Inn from 5:00 to 7:00 pm. It is a unique, fun gathering to celebrate our elders before us and to foster networking and business development opportunities.

Thank you to all our dedicated speakers for their time and efforts. Speakers are the heart of this symposium and we are grateful that they share their expertise. Special shout-out to committee members; Kip Peterson, Colleen Hahn, Gard Clark, Veronica Hernandez, and Chiara Parlagreco for making this all possible. I look forward to meeting up with everyone.

*William Kohnen*  
Track Chair, UI2020 Manned Submersibles  
Underwater Intervention

**Marine Technology Society**  
Manned Underwater Vehicles Cmttee, Chair

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# 2020 MANNED UNDERWATER VEHICLE SYMPOSIUM at Underwater Intervention, New Orleans, USA

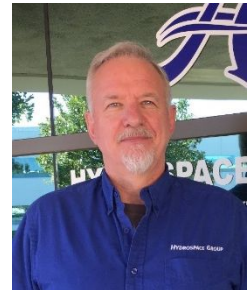
## Day 1 - Room 345 - Tuesday, February 4

8:30 – 9:30

### **Overview of Global Manned Submersible Industry Activity in 2019/2020**

By: William Kohlen, President/CEO, Hydrospace Group, USA

A yearly review of the state of the Manned Submersible industry in 2019/2020. The overview looks at operations and developments around the world in all branches, including international research, tourism activity, leisure and government/security. This includes a summary of submersibles under Classification, operating and in construction, review of the industry trends and regulatory highlights for the year.



9:30 – 10:00

### **DSV Alvin 2019 Operations and Scheduled 6500 m Upgrade**

By: Andy Whitman, ME Engr, Alvin Group, WHOI, USA

This presentation will detail DSV Alvin operations through early 2020, including the completion of Alvin’s science expeditions. Additionally, the engineering efforts to complete remaining systems conversion for 6500 meters operations are in the final stage, with mature designs nearing completion, and procurement of new components and materials underway. The presentation will provide information on the progress of these efforts, and the Alvin program’s plans to complete integration in 2020, and initial operations to 6500 meters scheduled in early 2021.



10:30 – 10:30  
10:30 – 11:00

COFFEE BREAK

11:00 – 11:30

### **The Triton 36,000/2: Building the world’s most extreme ocean exploration tool**

By: Patrick Lahey, President, Triton Submarines, USA

The presentation presents Triton’s role in the Five Deeps Expedition (FDE), and specifically, the full ocean depth (FOD) capable submersible the company designed, engineered and built for the FDE. The Triton 36,000/2 or FOD Triton is a technological ‘tour de force’, which has made it possible for human beings to explore and conduct scientific research in the deepest, most remote and least understood areas of the world’s oceans (the Hadal Zone, which lies between 20,000 and 36,000 feet or 6,000 and 11,000 meters) for the first time in history.



The FOD Triton project has consumed my life, and the lives of many other people at Triton, for the last four and half years and it will be the subject of many conversations in the coming month. In addition, the FOD Triton plays a starring role in the five part Discovery Channel documentary (Deep Planet), which will be released in February 2020.

11:30 – 12:00

### **Subsea Innovation Needs for Reef Restoration: From Shallow to Deep Sea Corals**

By: Sara Frias-Torres, Senior Strategy Manager, Coral Reef Conservation, Vulcan Inc., USA

The techniques developed for large-scale coral reef restoration in shallow water corals (depth range less than 50m) can be extrapolated to the restoration of deep-sea coral populations. However, the ability to incorporate subsea innovation has the potential to add automation and scale up restoration in both shallow coral reefs and deep-sea coral communities. Using a shallow water restoration project, we will explore how technical protocols can be translated to deep-sea coral restoration and aided with subsea innovation in both communities. A large-scale coral reef restoration project was completed at Cousin Island Special Reserve, Republic of Seychelles. Using “coral gardening”, first, coral fragments were harvested from donor colonies and grown in mid-water rope nurseries for 1 year. Second, the nursery corals were transplanted to a degraded reef site. We transplanted 24,431 corals of 9 species (*Acropora hyacinthus*, *A. cytherea*, *A. abrotanoides*, *A. sarmentosa*, *A. muricata*, *A. lamarcki*, *A. appressa*, *Pocillopora verrucosa* and *P. grandis*) to 0.5 ha of degraded reef. Mean coral survival from nursery to transplantation was 75.2 %. We scaled-up experimental-sized restoration techniques. Using biomimicry, we developed time-saving “cleaning stations”, so fish conditioned corals prior to transplantation. Animal-assisted cleaning at nurseries reduced person-hours 2.75 times. The restoration enhanced coral settlement and recruitment, increased fish biomass, and had lower bleaching rates than natural reefs. The use of cement and natural substrate to transplant corals, big nursery-reared colonies (10-20 cm wide), high transplant density (4-8 corals/m<sup>2</sup>) and a species composition similar to a healthy coral reef were critical for success. In coral gardening, the transplantation phase is the main limiting factor for scaling up operations because it largely depends on SCUBA divers attaching corals one at a time. Here, I analyze the restoration protocols that could be aided or replaced by subsea technology using remotely operated vehicles in shallow water coral reefs and the combination of ROVs and manned submersibles in deep-sea coral communities.



12:00 – 12:30

### **SEAmagine AURORA submersible design features after 25 year’s development**

By: Charles Kohnen, President, SEAmagine Hydrospace Corp, USA

SEAmagine has been designing and building manned submersibles since 1995 and will present some of the key patented design features found on its latest AURORA model series of which the first few have now been delivered. SEAmagine has seen the manned submersible industry and its market change during the past 25 years, and will present how it is answering the growing demand of a market that it pioneered since the mid 1990’s.



12:30 – 1:00

**LUNCH BREAK**

1:00 – 1:30

**KEYNOTE ADDRESS – MAIN EXHIBIT FLOOR**  
**Supplier Solutions Theater**

**NOAA Supports the 21st Century Blue Economy**

By: Philip A. Hoffman, Unmanned Maritime Systems R&D  
Coordinator  
NOAA Research Office of Ocean Exploration and Research



This will present updates on NOAA's activities to support the Blue Economy nationally and internationally, including:

- A high-level overview of the NOAA Priorities (such as the recently released 4 S&T strategies on AI, UxS, Cloud Computing and Omics)
- How NOAA is implementing the Weather Act
- NOAA support to the UN Decade of Ocean Science for Sustainable Development to increase awareness and inform the UI audience of the timeline.
- NOAA activities to Implement the Commercial Engagement Through Ocean Technology (CENOTE) Act of 2018 in the Gulf Region.

1:30 – 2:15

**FILM FESTIVAL**

*MUV INDUSTRY ACTIVITY in 2019*

**MAIN EXHIBIT FLOOR - Supplier Solutions Theater**

This series of 45 minutes presents a variety of videos from Manned Submersible manufacturers and operators around the world, taken from operations and expeditions in 2019.

**SPONSORED By:**



2:15 – 2:30

**LUNCH BREAK**

2:30 – 3:00

### **The LULA1000 - a reliable tool for deep-sea quality filming and research**

By: Kirsten & Joachim Jakobsen, Rebikoff-Niggeler Foundation, Azores, Portugal

The LULA1000 has been working extremely reliably since she was put in operation in the year 2013. The LULA1000 is a unique tool for underwater quality filming. Even in-situ macro photography is possible by means of a unique retractable aquarium mounted to the sub. Images have been used for ocean documentaries, scientific publications, as well as for exhibits such as in the European Parliament in Brussels. The sub has been optimized for quality filming, to fulfill the requirements of the big nature documentary channels, like the BBC, National Geographic, ORF, and others. Images taken with the LULA1000 have been used for productions such as the whale fall in Blue Planet II (BBC), Atlantic - the Wildest Ocean on Earth (BBC2), Life at the Extreme (iTV), Wildlife Azores (NHK), and others. The discovery of the wreck of the German WWII U-boat U-581 in 870 meters of depth in the Azores made it to the news in 26 countries. The first ever documentation of a deep-sea anglerfish pair also has been a great media success and one of the top stories in Science Magazine. With the LULA1000, it was also possible to first ever document a hunting pelican eel. Our film DEEP TIME has toured several nature film festivals in Europe and Overseas. Different scientific work - habitat mapping and sampling as well as deployment and recovery of experiments - has been carried out in collaboration with research institutes such as the University of Cologne/Germany, the Alfred Wegener Institute in Bremerhaven/Germany, the University of the Azores and the Governments of the Azores and Madeira. In August this year, the LULA1000 was transported to Madeira onboard its support catamaran ADA REBIKOFF for the DEEP MADEIRA project, a collaboration with the Government of Madeira. The LULA1000/support catamaran system will remain in Madeira until at least summer 2020 for ongoing research work. ADA REBIKOFF is equipped with side scan sonar and magnetometer with 2200m cable, Multibeam sonar, workshop and a video editing suite. In 2018, the sub passed the 5-year class renewal inspection by DNV-GL.



3:00 – 3:30

### **2019 ICTINEU 3 exploration of the Canary Islands continental slope**

By: Pere Forès, Co-Founder/Dir. Engr, Ictineu Submarins SL, SPAIN

In October 2019 The ICTINEU 3 team moved recently to Gran Canaria, one of the 7 islands in the Spanish Canary archipelago, 200km West from the African NW coastline with a challenging mission: to make a series of dives off the Eastern coast of Gran Canaria and being the expedition base the Oceanographic Platform PLOCAN. The Oceanic Platform of the Canary Islands (PLOCAN) is a Research Infrastructure co-funded by the Ministry of Science, Innovation and Universities of the Spanish government and the Canary Islands government and by the European Regional Development Fund (ERDF) under the Operational Program of the Canary Islands. PLOCAN is a multipurpose technical scientific service infrastructure that provides support for research, technological development and innovation in the marine and maritime sectors, available to public and private users. PLOCAN offers both onshore and offshore experimental facilities and laboratories and brings a broad experience in large national and EU marine/maritime projects. The PLOCAN Platform is an offshore facility, an infrastructure, built over a caisson which rests on the seabed. It is located 1 Nm offshore, in the NE of Gran Canaria at 30.5 m depth and with a Surface of 5000 m2. Surrounding the Platform there is a dedicated experimental test bed that comprises a marine smart grid with communications and power that can be provided to and from the test bed equipment. Emerging technologies like ocean wind turbines, wave energy converters, offshore aquaculture and new observation systems can be tested there in real conditions.



The submersible was deployed from the Platform every day and will sail some 2 to 4 km distance to the slope area to make 3 transects between 400m and 80m depth. The test site has an area of 23km<sup>2</sup> and a depth between 10 and 600 meters depth. This includes part of the continental shelf and slope of the Island that run along 4,5km parallel to the coast. The test area comprises a smooth area with a 5 to 9% slope (continental shelf) as well as a steep area with slopes between 18 and 27% which has to be explored. A small sea-mount and two well-defined canyons are within the area. The shallow part of the test side has been well explored and mapped with different technologies and habitat and geological detailed maps have been produced for an extension down to 60 meters depth. Canyons and slopes ranging from 100 to 600 meters depth have not yet been explored and a series of transects have been planned with the submersible. Video image will be taken in order to have a first overview of the area and specific sampling is also scheduled. What can be found in the deeper depths of the Island looks promising and raises expectancy. The Canary Islands hold some of the largest and last colonies of angel shark, *Squalus squatina*, and the test site is close to special conservation areas and on the way of migratory paths for cetaceans and sea turtles, in addition to be a volcanic region with depths dropping steeply to 4000 meters.

3:30 – 4:00

**Deepflight Phoenix Operations in 2019 / 2020**

By: Chris Welsh, LLC Manager, Deep Sub/DeepFlight LLC, USA

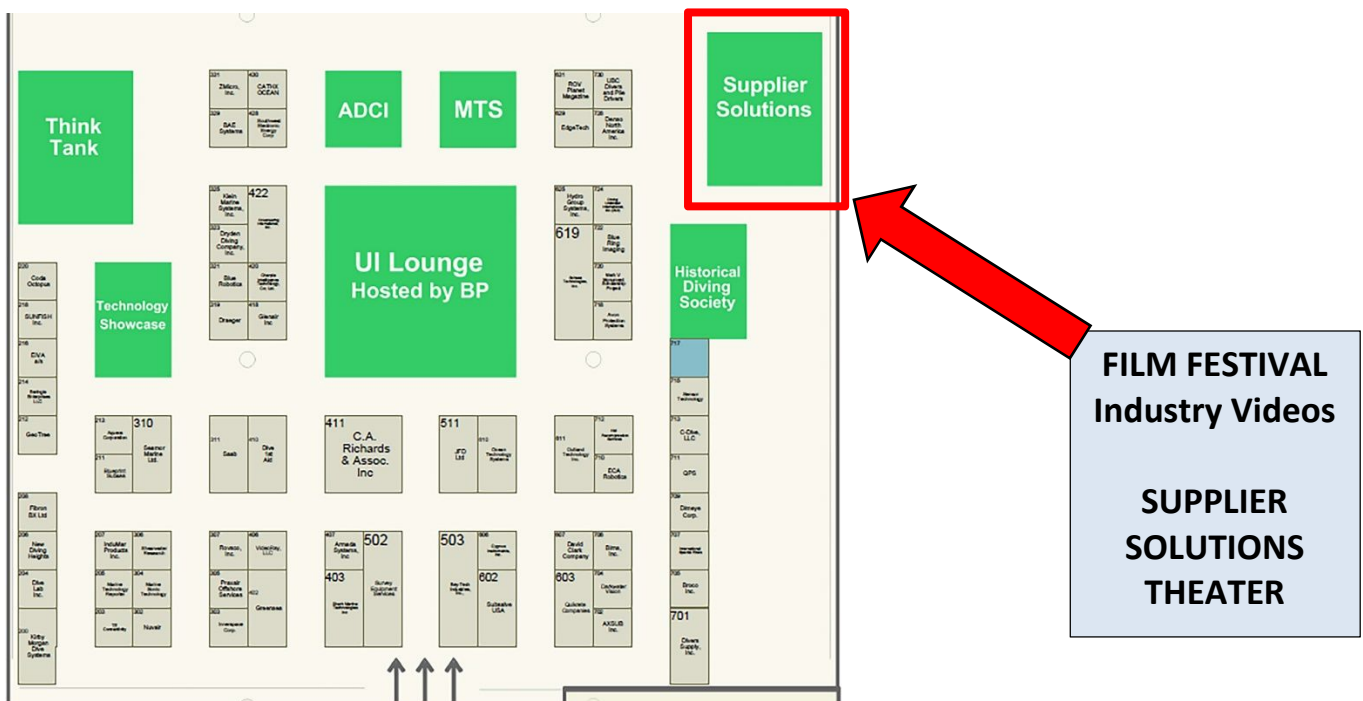
A review of the Deep Sub 2019 Pacific expeditions. The presentation will also review the acquisition of DeepFlight and the 2020 production and deployment plans for the DeepFlight Super Falcon 2 and Super Falcon 3S submersibles in current inventory.



4:00 – 4:30

VISIT UI EXHIBIT SHOW FLOOR

4:30 – 5:00





Please Join us for the  
**MTS MUV Cocktail Reception**  
HAMPTON INN HOTEL – 5:00 to 7:00



**5:00 – 7:00 HAMPTON INN HOTEL - OPEN RECEPTION FOR ALL**

COME and JOIN US – CELEBRATE with Friends!

Refreshments and catching up with MUV colleagues and friends.

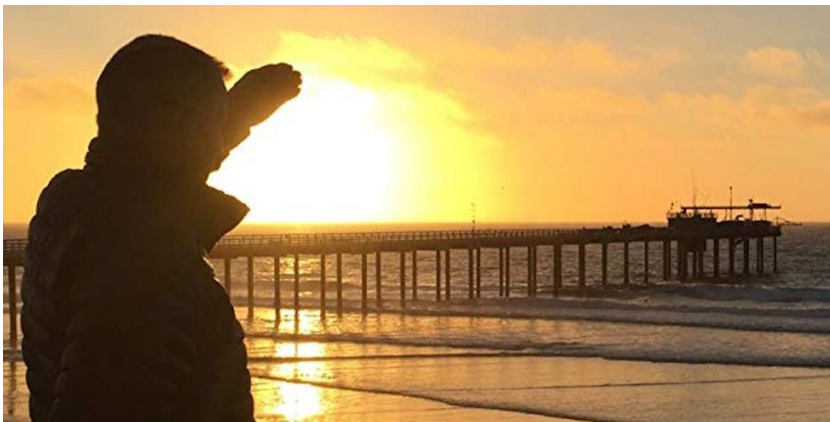
The Hotel is just across the street from the Convention Center.

## MUV 2020 RECOGNITION OF DEEP OCEAN PIONEERS

As we celebrate and recognize the 60<sup>th</sup> Anniversary of deep ocean exploration with the TRIESTE and 50<sup>th</sup> Anniversary of human Moon exploration of Apollo 11, the MUV community celebrates:

**WILL FORMAN, Designer & Pilot**

**DEEP SUBMERSIBLE PILOT ASSOCIATION, 1968 - 2018**



Will Forman, San Diego CA 2020



DEEP JEEP 1963

It is 1960, Trieste just made its historic dive. Will Forman, WWII fighter pilot, is at China Lake Navy Facility working on small submersible ideas. He talks with Cousteau's team and their Soucoupe from 1959, the NEL Team from the Trieste, discusses the ideas for SeaPup that will lead to the historic ALVIN. He receives funding for the first small US made submersible in Fall of 1960. Deep Jeep is launched in 1964. By 1966, Will Forman designs and builds the first acrylic sub, the Kumukahi, years ahead of its time. He is an original founder of the Deep Submersible Pilot Association, one of the earliest organizations to steward the operational aspect of manned submersibles. Sixty years later he still has untold stories.

# 2020 MANNED UNDERWATER VEHICLE SYMPOSIUM

## Day 2 - Room 345 - Wednesday, February 5

8:30 – 9:00  
9:00 – 9:30

### **ABS ANNUAL INDUSTRY MEETING**

#### **Overview of ABS Underwater Rule Change Proposals for 2020**

By: Roy Thomas, Sr Principal Engineer, ABS Americas, USA

The American Bureau of Shipping (ABS) Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities, commonly known as the “Underwater Rules”, are the primary ABS Rules for classification of underwater units. These underwater units include manned submersibles, lock-out submersibles, diving systems, atmospheric diving suits, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and so forth that are used for commercial, scientific, and government applications. This industry meeting gives an overview of the annual ABS Underwater Rule change proposals and provides further insight into the rationale and basis for each proposed Rule change. Following this overview, the meeting includes a question-answer session and facilitates an open dialogue with the industry on current technical issues. All active designers, fabricators, owners and operators are invited to attend and provide feedback.



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9:30 – 10:00

### **Underwater Vehicle Video Requirements**

By: Leonard Pool, Managing Director, Sidus Solutions, USA  
Sheldon Rubin, Engr Director, Sidus Solutions, USA

If you hope to accomplish anything useful, you cannot blindly operate a vehicle under the water, whether remotely or in person. There are three sensors that are generally considered indispensable for the safe and efficient operation of underwater vehicles: video, heading and depth. Arguably, being able to see where you’re going and what’s in front of you is the most important requirement of all. Until recently there was no way of doing this without a video camera. While awkward, operators possessing lots of skill and experience can substitute high resolution imaging sonars for video in limited cases. This is a choice of last resort but may become more common as the sonar image quality improves. Video cameras are still the tool of choice and their use has become ubiquitous. Video cameras have been an enabling technology for underwater exploration, documentation and exploitation.

As virtual and augmented reality becomes more mainstream, it is becoming more common to record VR180 hemispherical video or monoscopic or stereoscopic 360 (full spherical) video. Not all VR video experiences are created equal. VR180 is a video format for stereoscopic, hemispherical video defined by Google to be a new immersive media format on YouTube. While Google appears to be abandoning the format, the name is still being used. For VR180 video, two parallel cameras are used to obtain two slightly different points of view and then let the viewer’s own visual system perceive stereoscopic depth. The amount of stereo depth is defined, in part, by the separation of the camera lenses, which defines the relative parallax differential between the left and right eye images. If the distance between the camera lenses differs significantly from the distance between human eyes, the experience may not be seen as natural or immersive by the viewer and can even cause headaches due to the abnormal feeling of the stereo effect.



There is little or no standardization of 360 video equipment, but there are two basic approaches. The smaller, more cost-effective approach is to use two fisheye cameras facing in opposite directions. Each camera must have a wide enough AOV to allow sufficient image overlap to stitch the two images together into a single spherical image. There are a couple of potential disadvantages to this approach. Most fisheye lenses cause image distortion and loss of resolution at the periphery of the image. However, some fisheye lenses do compensate for this effect and prevent loss of resolution or image distortion. Overall loss of resolution is another problem, even when using two UHD 4K cameras. While the cameras have high resolution, they also have a very wide AOV so the pixels in the image cover a much larger area and there are fewer pixels per unit area. However, it is possible to stitch the two images together in real time to provide immediate 3D viewing. Currently the resolution sweet spot for this method is 5K resolution, slightly better than UHD 4K. New cameras will be available soon that will provide 8K resolution, four times better than UHD 4K, in real time. This type of 360 video camera can be housing in a small enough pressure vessel to satisfy PVHO safety requirements without the need for certification.

10:00 – 10:30

## COFFEE BREAK

10:30 – 11:00

11:00 – 11:30

### United States Navy Submarine Rescue Systems TUP Certification and New Capabilities

By: Cpt Robert A. Wolf, Submarine Escape & Rescue Program Manager  
US NAVY- NAVSEA PMS391, USA

This presentation will serve to update government and industry partners on the status of SRDRS Submarine Rescue System operation and the certification of its Transfer Under Pressure (TUP) capabilities.



The Submarine Rescue Diving and Recompression System (SRDRS) performs rescue operations on submerged, disabled submarines of the U.S. Navy or foreign navies. SRDRS is designed for quick deployment in the event of a submarine accident. It is transportable by truck, aircraft or ship. At the accident site, the SRDRS works with a "mother ship" known as a vessel of opportunity (VOO). The SRDRS is a tethered, remotely-operated vehicle with two on board system operators that is launched into the water and mates to the disabled submarine's hatch. SRDRS can embark up to 16 rescued personnel for transfer to the "mother" vessel. The SRDRS consists of three systems:

1. Assessment/Underwater Work System (AUWS). Consists of a Remotely Operated Vehicle (ROV) for assessment of a disabled sub and rescue hatch clearance down to 2,000 feet of seawater.
2. Submarine Rescue System - Rescue Capable System (SRS-RCS). RCS Pressurized Rescue Module (PRM) provides a tethered, remotely-operated vehicle capable of rescuing 16 personnel per trip.
3. Submarine Decompression System (SRS-SDS). Will provide a transfer-under-pressure capability for hyperbaric treatment of Sailors rescued from a pressurized sub.

## US NAVY – PANEL DISCUSSION

11:30 – 12:30 **Underwater vehicles tracking & navigation from vessels of opportunity**



Cpt Robert A. Wolf,  
Submarine Escape & Rescue  
Program Manager  
US NAVY - NAVSEA PMS391  
USA



Mark SCHLEEF  
Global Rescue Operations  
Undersea Rescue Command  
US NAVY - NAVSEA PMS391  
USA



Matthew Z. Wehner  
Sub Rescue Contract Mgr  
Phoenix International  
Holdings, Inc.  
USA

This panel discussion will address the latest technologies and challenges with tracking of underwater vehicles when operating from a vessel of opportunity. Specifically, the discussion will address state-of-the-art tracking techniques and instruments to improve accuracy and reliability under adverse surface and water conditions. These include a wide range of acoustic interference challenges arising from operation in very cold waters and associated thermoclines, thruster noise from the submersible vehicle as well as acoustic interference from the DP vessel and its propulsion system.



### PANELISTS:

#### **Dan Zatezalo, Technical Sales Manager, Sonardyne Inc., UK**

Sonardyne’s SPRINT-Nav is a self-contained Inertial Navigation System (INS), Doppler Velocity Log (DVL) and high accuracy pressure sensor in a single housing. This tightly integrated Hybrid Acoustic Inertial Navigation System is providing unparalleled navigation performance while making integration easy. A single power/comms connection could be used to retrofit the SPRINT-Nav to the SRDRS sub rescue system to provide an INS solution for positioning and navigation purposes.



#### **Ben Kinnaman, CEO & President, Greensea Systems Inc., USA**

Modern off the shelf navigation and tracking solutions provide excellent subsea position solutions but often within a narrow window of operation. For reliable and robust operation over a broad set of conditions, a highly integrated solution tailored to the exact CONOPS is often required. A one-size-fits-all COTS product may not be as effective for positioning on a system like SRDRS as a tightly integrated system of several COTS products and an engineered fusion solution.



#### **Rico Castelo, VP of Sales and Marketing, Rowe International Inc., USA**

A DVL can be used for navigation underwater. A DVL is capable of measuring “speed over ground” and the range to the bottom. With this information, a DVL can be used for dead-reckoning. When a DVL is integrated into an INS system, the DVL can be used to reduce errors caused by long-term drift in the INS. In an underwater mission, where GPS is not available, a DVL is necessary for accurate navigation.

12:30 – 1:00	<b>LUNCH BREAK</b>
1:00 – 1:45	<p style="text-align: center;"><b><i>UNMANNED SYSTEMS ACTIVITY in 2019 – FILM FESTIVAL</i></b></p> <p style="text-align: center;"><b>MAIN EXHIBIT FLOOR</b> <b>Supplier Solutions Theater</b></p> <p>Announcement by Ocean Infinity followed by a series of industry videos from ROV, AUV and UUV manufacturers and operators from operations in 2019.</p> <p><b>SPONSORED By:</b></p> <div style="text-align: center;">  </div>
1:45 – 2:00	<b>LUNCH BREAK</b>

2:00 – 2:30

**Citizen Submariners**

By: Alec Smyth, Innerspace Science, USA

When retired US Navy submariner George Kittredge started building mini subs in the early sixties, he inadvertently launched a small movement. To this day, a small fraternity of enterprising individuals continue to build and operate their own submersibles. Their boats are typically trailerable behind a SUV and can launch from ordinary boat ramps. Operating costs are minimal, but these subs can safely go far beyond SCUBA depths and remain there for hours. Three years ago, innerspacescience.org was set up to make personal submersibles available to scientists free of charge. On land, the subs are also used for educational activities such as science fairs or STEM after-school programs. In the current year, enrollment in the after-school programs grew by 300 percent.



2:30 – 3:00

**Overview of research operations with manned submersibles**

By: Dana Wilkes, Marine Operations Manager, NOAA Nat’l Marine Sanctuaries, USA

As our planet, Earth, enters yet one more evolutionary change, all eyes are turning to its oceans. From coastal zone to Hadal zone and all depths in-between, the answers as they say, “lie within”. The topic of using manned submersibles in scientific, commercial, and exploration applications has been around for over half a century. Actual use and popularity have waxed and waned over the years. Today, a new world of submersibles has entered the arena. High end exploration, luxury adventures vehicles, and technologically advanced platforms are now common,



accessible, and operating. In the early years, getting a talented set of eyes to depth in the environment, to see the data first hand was not a small task. Just the weight of a submersible proved daunting to safely handle the air-sea interface. But the large end of the equation included a support ship, operations, personnel, safety equipment, and redundancy. All these non-submersible requirements had a price that could be measured in dollars per pound. Today, technology has directly impacted that equation. Technology in materials, mechanics, and apparatus has changed the investment. Technology has provided enhancements in batteries, operations, power to weight, size, efficiency, and safety.

So, how has the standards, guidelines, and oversight, evolved during this period of enhancement. The MUV of MTS is currently a forum for professional Submersible discussions. As such, it could serve as a seat for review of submersible oversight guidance. The topic areas of design and construction has almost always resided with the technical branches of certifying authorities. Classing submersibles, addressing operations, pilot training, and safety are topic areas that could be reviewed at intervals to remain current.

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3:00 – 3:15 **COFFEE BREAK**

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3:15 – 3:30 **Overview of Major Marine Incidents in 2019 and renewed regulation enforcements**

By: Kip Peterson, Founder and CEO of Thorsborg Institute, LLC, and US Merchant Marine Master, USA

The presentation provides a brief overview of major marine incidents in the past year that have made a significant impact on the perception of liability and insurability of sea-born equipment and compliance with enhanced enforcement by the authorities for maritime operations with these incidents' impact/influence on the evolving MUV's Consensus Standards.



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3:30 – 4:30 **MUV Workgroup: MUV Operations Consensus Standard**

By: Gard Clark PMP, Captain, USN (Ret.), MTS MUV Committee, USA  
Colleen Hahn, Gryphon Strategies, MTS MUV Committee, USA

The MUV industry continues its work on the development of an Industry Best Practices based consensus standard for the operation of manned underwater vehicles. The workshop continues the work of bringing MUV industry best practices into a single document guiding safety standards for operation of manned undersea vehicles. Open to all MUV members.



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4:30 – 5:15 **ANNUAL MTS MUV COMMITTEE MEETING**

By: William Kohnen, Chair, MTS MUV Committee, USA  
Colleen Hahn, Marketing, MTS MUV Committee, USA

ALL MTS MUV Members and Industry delegates are invited to attend, participate and join in the planning for the committee work for 2020.

# 2020 MANNED UNDERWATER VEHICLE SYMPOSIUM

## Day 3 - Room 345 - Thursday, February 6

8:30 – 9:00

### 60 Years History in Manufacture of Acrylic windows for Deep Submersibles

By: Jarl Stromer, Manager Class Compliance, Triton Submarines, USA  
 Wolfgang Stuber, Product Manager, Roehm GmbH, Germany  
 Jakob Sixl, Heinz Fritz GmbH, Kunststoffverarbeitung, Germany



On January 23, 1960, the manned submersible Trieste made an historic record setting dive to the deepest point in the Earth's oceans. The event marked an important milestone in mankind's insatiable quest to explore the unknown. For outward visibility, the Trieste was fitted with two viewports. The acrylic windows were supplied by Röhms and Haas of Darmstadt, Germany. We commemorate this anniversary today by presenting some of the advancements in production and manufacturing of acrylic windows for manned submersibles made by Röhms Industries and Heinz Fritz GmbH. With state-of-the-art acrylic technology, these companies supplied the windows for the Triton 36000/2 submersible (Limiting Factor) which has been making multiple dives to the deepest points in many of the earth's oceans for the past year as part of the Five Deeps Expedition.

9:00 – 9:30

### Aftercare and Inspection of Acrylic Windows

By: Guy Richards, Director, Blanson Ltd, UK



If you want an all-singing, all-dancing submersible, how to ensure the window remains fit for purpose for its entire service life? PVHO grade acrylic is a very robust and well-known material that has been used for pressure vessels for more than 60 years. Unlike glass or polycarbonate, acrylic has a very forgiving failure mode if mistreated, is thermally shocked or has a dangerous solvent applied to it. The purpose of this paper is to discuss some of these signs of distress and what is recommended can be done to avoid serious damage. The window is the most visible and may be one of the single most expensive components in the Submersible. Treat it gently!

9:30 – 10:00

### Spacecraft Window Environmental Considerations and Design Evolution

By: Lynda Estes, Manager Structures Branch/ES2, NASA JSC, USA  
 Hannah Bradley, ISS Window Subsystem Manager, NASA JSC, USA



This presentation will describe the environmental considerations associated with spacecraft window design and NASA efforts over the years to address these conditions. NASA window designs have evolved from all glass pane window designs to hybrid systems with glass and plastic panes. NASA has embarked on an ambitious testing campaign to characterize plastics for the spaceflight environments to support continued design innovation.

10:00 – 10:30

COFFEE BREAK

10:30 – 11:00

### **Debarkation Syndrome and Commercial Submarine**

By: Bart Kemper, Principal Engineer, Kemper Engineering Services, LLC  
Krista Kemper, President, Kemper Engineering Services, LLC, USA

Debarkation Syndrome, or more properly Mal de Debarquement Syndrome (MdDS), is a neurological disorder that most commonly develops following an ocean cruise or other type of water travel and less commonly with other motion experiences. It is also known as “Land Sickness” or “Drunken Sailor Syndrome” when applied to professional sailors. The symptoms include continuous feeling of swaying, rocking, and/or bobbing, coupled with other neurological distress. Symptoms can be sufficiently severe to interfere with unassisted walking, the ability to concentrate, or otherwise prevent people from working. Research is showing it is more commonly than originally thought since a MdDS diagnosis must meet specific testing criteria and may be misdiagnosed as “persistent vertigo” which is unresponsive to typical treatments. The reason it is of interest to Manned Underwater Vehicles is the method used to induce MdDS in test subjects is identical to some of the common maneuvers of submersibles. One of the authors, Krista Kemper, developed chronic MdDS during a commercial submarine voyage. The presentation summarizes the science and medical aspects and provides recommendations to reduce the probability of inducing MdDS in MUV passengers or crew.



11:00 – 11:30

### **Additive Manufacturing and 3D Printing for Manned Underwater Vehicles**

By: Steve Smith, President & CEO, ProTek Models, LLC, USA

Over the past decade 3D printing has moved from an era of 3D printing for prototypes only into an age of high performance production grade parts. Today’s machines produce the highest quality most dimensionally accurate FDM 3D printed parts with the widest range of high performance thermoplastics. Stratasys invented FDM 3D printing and has stayed the leader in this technology. These line of printers are the highest performance FDM 3D printers in the industry. Parts produced with these machines have tolerances 0035 in. or +/- .0015 in. The extensive portfolio of materials consists entirely of engineering grade thermoplastics. ABS and ASA are the standard for prototype parts and lower strength production applications. ABS ESD7 is an outstanding material for contact with sensitive electronics. Nylon 12, Nylon 6, PC-ABS, and Polycarbonate are higher performance materials that are suited for production grade parts for a wide range of applications. Nylon 12CF, Ultem 9085, Ultem 1010, and Antero 800na/PEKK are the most exotic and high performance thermoplastics with incredible strength and temperature ratings. Materials like Ultem 1010 offer incredible strength and a heat deflection temperature of 420 deg Fahrenheit. Ultem 9085 is a very high strength 3D printing material that is FAA approved for aircraft interiors and has a HDT of 307F. Nylon 12 CF is an extremely rigid high performance thermoplastic that is excellent for prototype and production applications requiring outstanding rigidity. 3D printing presents new manufacturing options for the Manned Underwater Vehicle industry due to the often-low volume production requirements. Parts can be printed very quickly and efficiently and can save time and money on production.



11:30 –12:00

**ABS on Additive Manufacturing for Manned Submersibles**

By: Jess Totten, Managing Principal Engineer, ABS Engineering Services Department (ESD), Houston, USA

Additive manufacturing, commonly referred to as 3D printing, is becoming increasingly common and powerful form of fabrication. Additive manufacturing offers several potential benefits to the designer of small private submersibles, from reduction in weight and complexity, to increases in durability, speed of fabrication and the ability to conform to confined, irregularly shaped spaces. Materials used for additive manufacturing can be plastic, metal, ceramic or even living tissues. In general, we expect that materials for purposes of interior outfitting would generally be plastic. Components fabricated using additive manufacturing would be subject to the same requirements of the Underwater Rules as any other non-metallic component. Section 3/1 of UWR requires materials will “not give off noxious or toxic fumes within the limits of anticipated environments or under fire conditions.” Also, internal materials are to be “constructed of materials that are fire-restricting under the anticipated environmental conditions.”



12:00 –12:30

**Full Ocean pressure-tolerant li-po batteries: expanded performance and future challenges**

By: Carme Parareda, Co-Founder/COO, ICTINEU Submarine SL, SPAIN

ICTINEU Submarins S.L. was the first company to build up and implement a high capacity, certifiable, fully functional, robust, safe and repeatable lithium-based solution for underwater vehicles. Initially designed and certified for the ICTINEU 3 manned submersible rated 1000 meters depth, the 148VDC – 10,36 kWh battery module evolved through years to the third-generation package which in 2018 was qualified for 11500 meters depth and achieved a DNVGL certification approval for the deepest human occupied vehicle that has ever been at the bottom of the sea. Each 10 kWh Ictineu li-po battery can be used as a standalone module or in multiple modules assembly to form large capacity banks with few elements and wiring. In both cases it works as a plug & play system easy to install in any type of vehicle and is safe in operation as it has all the required control and safety elements built in. In addition, each module has built-in safety fuses, contactors and redundant temperature sensors which add robustness, safety and protection. Safety elements are important not only to protect the battery itself, but also to protect the operator from accidental discharges or shorts when we are talking of 148VDC. The 10 kWh modules have proved to be effective and the most cost-efficient solution on large vehicles. On the ICTINEU 3 submersible for example, only 4 modules and a weight of 500 kg allow the vehicle to perform up to 20 miles underwater while typically such vehicles can only dive for 2 to 3 miles on the sea-floor in a normal mission.

Compliance with certification agencies will become more challenging as new regulations apply to embark lithium powered vehicles on board the mother ships. The ICTINEU batteries have passed a number of DNVGL, IEC and UN regulations -including environmental and fire propagation tests- and therefore they are compliant with the strictest requirements from certification agencies which, at the last instance, will allow or not the vehicle to be boarded on the operating vessel. Fourth generation ICTINEU battery status will be presented as well as the validation and certification program to be applied both for atmospheric and under-pressure charge conditions.



## 2020 MUV SPEAKER BIOS



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**Rico Castelo** is the technical Sales Manager of Rowe Technologies, In the past, he was customer service and a software developer for ADCP and DVL. Rico previously worked at Teledyne RD Instruments in the Software/Firmware department, Customs department, and Manufacturing department. He has basically worked on every aspect of an ADCP over his career: building, testing, training and now selling and marketing ADCPs and DVLs. He is just following in the same footsteps as other greats in the ADCP industry.

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**GARD CLARK PMP**  
**Captain, USN (Ret.)**

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**Captain Clark** is a career submariner whose undersea experience includes 31 years in the United States Navy culminating with command of the USS DALLAS (SSN-700), a fast attack nuclear powered submarine specially equipped to carry the Seal Delivery Vehicle (SDV). The SDV is a deployable MUV housed in a Dry Deck Shelter on the deck of the larger submarine and is a "wet submersible" where operators wear scuba gear and are exposed to the ocean environment. While in command, Captain Clark conducted operations with special forces using the SDV during two six-month deployments to the Middle East and Indian Ocean. Following command at sea Captain Clark served as the Major Program Manager for Naval Sea Systems Command (NAVSEA) PMS-399--Special Operations Forces Undersea Mobility Program Office. There he was responsible for sustainment and development of Dry Navy Submersibles as well as Dry Deck Shelters and other submarine Deep Submergence Systems including maintaining Scope of Certification for manned operations. Following retirement from the Navy in 2012, he joined Teledyne Brown Engineering, Inc. where he currently serves as Vice President leading the Energy and Environment Business Unit. Teledyne Brown Engineering is the designer and manufacturer of the US Navy Shallow Water Combat Submersible which is the follow-on vehicle to the SDV. Captain Clark is a member of the Marine Technology Society's Manned Underwater Vehicle Committee.

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**HANNAH BRADLEY**  
**ISS Window Subsystem Manager**  
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**Hannah Bradley** is a structural engineer and spacecraft window subject matter expert at the NASA – Johnson Space Center. In 2008, as a co-operative intern, Hannah was the first to suggest acrylic for use as a spacecraft window material in the Orion multipurpose crew vehicle, in lieu of the typical use of glass windowpanes. In the 11 years since, Hannah has been building her expertise while working on Space Shuttle, Orion, and Commercial Crew Program windows. She currently serves as the Window Subsystem Manager for the International Space Station, and lends her knowledge to the fledgling Gateway, Human Landing System, and Rover Programs. Hannah has helped with the development of a Window Material Database which aims to characterize a variety of clear materials for use as window in the space environment.



**LYNDA ESTES**  
**Sub-System Manager**  
**Structures Branch/ES2**

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**Lynda Estes** began working at NASA after graduating with a B.S. in Aerospace Engineering from Texas A&M University in 1987. After spending 4 years working as a structural design analyst for mechanisms, Lynda transferred to the Structures Branch in the Structures and Mechanics Division at JSC. In 1992, she became the Subsystem Manager of the Orbiter Crew Module, Airlock, and Windows. For the next two decades, she would be the sole expert at NASA responsible for human-rated spacecraft windows. During the mid-1990's she also became the Subsystem Manager for the International Space Station Windows, which included oversight of the qualification and certification processes for the US Lab, Cupola, common hatch and Japanese JEM windows.

In 2003, she became the lead NASA engineer responsible for guiding damage tolerant design upgrades to the Shuttle Orbiter windows following the loss of the Space Shuttle Columbia. In 2006, she was assigned as the Window Subsystem Manager for NASA's deep space multipurpose vehicle, Orion, an assignment she still holds today. In 2010, she was also assigned (concurrently with her existing assignments) as the oversight and subject matter expert for the Commercial Crew Program (CCP) Windows. This included working with NASA's CCP partners, SpaceX and Boeing, to ensure proper window design engineering is executed for the safety of the flight. Lynda regularly mentors young, "fresh out" engineers, along with her protégé and colleague of 10 years, Hannah Bradley. Together, Lynda and Hannah have taught lessons learned design approaches to human rated spacecraft windows to most of the aerospace industry and a few outside the industry (such as the Navy and Air Force).

In 2017, Lynda was granted funding by NASA HQ to develop a database consisting of performance data for candidate windowpane materials. This database, the Window Material Database or WinMD, performed testing on various materials such as glass, ceramics, acrylic and polycarbonate to characterize the performance in the spaceflight environments. The database is intended to provide spacecraft designers all the relevant data necessary to design lightweight window structures and make well informed design trades regarding materials for their windowpanes.

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**Pere Forès.** Industrial Designer. Co-founder, administrator and director of ICTINEU Submarins SL and cofounder of the Ictineu Institute, Catalan Submarine Research Centre in 2004. He has conceived and designed the ICTINEU 3 manned submersible for 1.200m. He has worked as an industrial designer, model maker, modeler, and after studying naval design has worked in the construction of recreational sailing and racing vessels for 15 years. He specialized in construction materials and processes involving composites and new materials. He built his first submarine at the age of 11, and later has designed and built his own sailing boats, being the last one an open racing ship with which he has crossed the Atlantic Ocean twice. He co-wrote the book *l'Atlàntic a quatre mans* (The Atlantic four hands).

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**SARAH FRIAS-TORRES, PhD**  
**Senior Strategy Manager, Coral Reef Conservation**

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**Dr Sarah Frias-Torres** is the Coral Reef Conservation and Restoration Specialist at Vulcan Inc, Seattle, WA, and a Research Collaborator for the Smithsonian Marine Station, Fort Pierce, FL, USA. Her research focuses on how coral reefs and marine megafauna can recover from overfishing and survive global climate change. Dr Frias-Torres has led large-scale coral reef restoration projects in Seychelles, Indian Ocean, and coral reef, mangrove and megafish conservation projects in Florida and the Caribbean Sea. She is a Fulbright Fellow, and a former Schmidt Ocean Institute Research Fellow, and US National Academy of Sciences Postdoc Fellow. She has worked at the U.S. National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA)-Kennedy Space Center and has been a consultant for the United Nations Development Program (UNDP) Dr Frias-Torres is committed to science communication and outreach using art, social media, documentary filmmaking and broadcast media (TV, radio).

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Colleen Hahn has more than 20 years of executive leadership helping companies, nonprofits and brands create revenue-generating opportunities to accelerate their growth. Her collaborative approach translates strategic concepts into tightly focused tactical campaigns that achieve financial, fundraising and marketing milestones. For commercial clients, Colleen has pioneered and branded new market sectors, expanded geographical channels and advanced financial investment opportunities in the United States and Europe. For nonprofit and associations, she has helped develop long-term strategic plans with a focus on fundraising, sponsorship and member/donor engagement. Since 1998, Colleen has worked both professionally and personally in the development, implementation, and activation of unique blended learning programs focused on STEM/STEAM summits, events, and educational initiatives for conservation, corporate and nonprofit sectors. Her innovative content has utilized multi-channel platforms with VR/AR and 360-degree technology to create communities, inspire audiences and increase performance. Colleen recently rebranded Gryphon Media Strategies to Gryphon Insight, a strategic business consulting firm focused on multiple solutions with one unique perspective. Gryphon's client-base spans a wide range of industries with one common value: effecting change through technological, creative and strategic innovation. Current clients include: 246 Years, 3D at Depth, Amazon Web Services, International Ocean Science and Technology Industry Association (IOSTIA), Morven Park, Northern Virginia Technology Council, One Blue Ocean and the Veteran's Employment Initiative.



**PHILLIP L. HOFFMAN**  
**Unmanned Maritime Systems R&D Coordinator**

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**Philip Hoffman** is leading implementation efforts under the Commercial Engagement Through Ocean Technologies (CENOTE) Act of 2018. Philip will serve as primary R&D liaison to the emerging NOAA UxS Operations Center; will manage CENOTE working groups within NOAA; serves as the primary NOAA staff lead for the NOAA Navy unmanned with the Office of Naval Research; and be NOAA's primary liaison to other federal agencies conducting UMS work, especially those activities taking place in the Gulf of Mexico. Philip will sit in the soon to be established NOAA UMS Operations Center in Gulfport, MS. In this role, NOAA will be leveraging Philip's broad relationships which he developed as both NOAA-OAR Evaluation Team Lead and NOAA Cooperative Institute Program Director. Prior to coming to OAR as the CI Director, Philip served in NOAA Fisheries as its Protected Species Program Coordinator and was part of the writing team for the original NOAA AUV Roadmap (2009). Philip started his federal career as a Biological Scientist and

Project Coordinator for the U.S. Army Corps of Engineers - Seattle District, focusing on salmon habitat restoration, Dungeness crab dredging mortality mitigation, salmon fish passage construction, and military construction environmental compliance. In addition, Philip has worked for the state of Florida, Pinellas County Florida, and a coastal NGO on Tampa Bay. He holds a Bachelor of Science Degree in Marine Science for Eckerd College, and a Masters Degree in Oceanography and Coastal Science from LSU. Philip is married to a NONESDIS Oceanographer and is the proud father of 5 kids. In addition to pursuing marine fish recreationally with a variety of gear, he serves as a Cub Scout leader, enjoys woodworking, and builds railroad models.

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## **KIRSTEN & JOACHIM JAKOBSEN**

### **Fundação Rebikoff-Niggeler**

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### **Joachim Jakobsen:**

Since 1974: photography and film work (16mm), scientific underwater film in the Mediterranean and the Red Sea;

since 1987: developments for underwater cameras and other technology;

since 1994: director of Rebikoff-Niggeler Foundation;

1997-2000: construction and building of the manned submersible LULA500;

2001-2012: operation of the manned submersible LULA500 in scientific and film projects;

2010-2012: design/construction of the LULA1000 manned submersible;

since 2012: scientific projects, habitat documentation and cinematographic work for nature documentaries with the LULA1000 manned submersible.

### **Kirsten Jakobsen:**

Since 2001: camera operator and navigator in the submersibles LULA500 and LULA1000 in scientific and film projects;

administrator of Rebikoff-Niggeler Foundation;

In hundreds of submersible dives to depths of up to 1000 meters in the Azores and Madeira Archipelagos, both discovered: coldwater coral reefs and gardens, deep-sea sponge fields, and the wreck of a WW II u-boat in almost 900 meters of depth. Several first-ever documentations of deep-sea fauna;

Scientific collaborations with universities, research institutes and regional governments

Film work for: BBC (whale fall for Blue Planet II), BBC II, National Geographic, iTV, ORF/ARTE/NDR, ZDF, NHK, RTP and other channels, as well as for nature film festivals.



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**Bart Kemper, P.E.** is the principal engineer of Kemper Engineering Services. He is also a member of the ASME Codes & Standards for PVHOs and Chair of the Viewports Subcommittee as well as part of the Emerging Technologies Task Force for the National Society of Professional Engineers. He has over two decades of experience in applying advanced engineering techniques in a variety of industries as well as in government service. He has authored numerous papers and patents, including previous work involving applying nonlinear Finite Element Analysis to acrylic marine viewports.

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**BEN KINNAMAN**  
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**Ben Kinnaman** is CEO and President of Greensea Systems, Inc. He has a Bachelor of Science in Physics from Davidson College and a master's degree in Mechanical Engineering, specializing in control and robotics, from Johns Hopkins University. Ben founded Greensea in 2006 to develop technology that improves the relationship between man and machine. Since that time, the company has developed OPENSEA, an innovative software operating platform for the marine industry, as well as commercial navigation and control products using the OPENSEA architecture. The fully integrated Greensea system is currently used by manned, unmanned, surface, and subsea vehicles for scientific, commercial, and military applications.

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**WILLIAM KOHNEN**  
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**William Kohnen** is president and Chief Executive Officer of HYDROSPACE Group Inc., a California company expert in manned submersibles and a wide spectrum of pressure vessels for human occupancy. Mr. Kohnen has 30 years of engineering experience combining expertise in electrical and mechanical engineering serving the aerospace, medical and subsea industries with a primary mission to promote new technologies for the management of world oceans and industrial infrastructure. Mr. Kohnen is chairman of the Marine Technology Society (MTS) committee on Manned Underwater Vehicles for the past 16 years and was made MTS Fellow in 2014. He has published many papers and articles on the state of the MUV industry. He is chairman of the Annual MUV Symposium held during the Underwater Intervention conference, in the USA, that brings the international MUV community together. Mr. Kohnen is a member of the ASME PVHO Safety Standards Committee, a member of the ABS Special Committee on Rules for Underwater Vehicles, Industry representative for DNVGL Underwater Technology Rules review, member of the Undersea and Hyperbaric Medical Society (UHMS), the Aerospace Medical Society and was member of the Deep Submersible Pilot association. Mr. Kohnen is Co-Founder of Seamagine Hydrospace Corp which designs and produces manned submersibles since 1995, with eleven vehicles distributed around the globe. Kohnen was born in Germany. He completed a bachelor and master's Degree in electrical engineering at McGill University, in Montreal, Canada. In 1986 he relocated to California to work in the aerospace industry, specializing in motor design and electromagnetic precision systems for satellite projects that included the Hubble Space Telescope, Space Station, SOHO and Cassini, among others.



**CHARLES KOHNEN**  
**President**

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**Charles Kohnen** is co-founder and the current president of SEAmagine Hydrospace Corporation which was established in 1995. SEAmagine is a leading designer and manufacturer of one atmosphere manned submersibles and has been one of the key pioneers over the years in the rejuvenation of this marine sector. Charles was SEAmagine's executive vice-president from 1995 to 2010 and is the president of the company since 2011. Prior to SEAmagine, Mr. Kohnen worked overseas in Africa, Asia, and Europe for the offshore oil service industry with Schlumberger International. Mr. Kohnen has Bachelor of Electrical Engineering and Business Administration from McGill University, Canada.



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**Patrick Lahey** is the co-founder and President of Triton Submarines in Sebastian, Florida. Born in Ottawa Canada, Patrick began diving in 1975 and started work as a professional diver in 1982. Patrick has nearly 40 years of commercial underwater experience earned from his involvement in a diverse range of projects spanning the globe. During his career, Patrick participated in the design, engineering, manufacture and testing of numerous underwater vehicles and diving systems including over 60 human occupied submersibles and is a fully qualified air, mixed-gas and bell-saturation diver with a background in electronics and instrumentation. In his role at Triton Submarines, Patrick has overseen the development of the company's entire range of submersibles, including the Triton 36,000/2 or Limiting Factor (LF), which successfully completed the groundbreaking Five Deeps Expedition in 2019. The Triton 36,000/2 is the first and only full ocean depth (FOD) capable human occupied submersible to be fully accredited by an internationally recognized third party classification society (DNV-GL) with an 'unlimited diving depth' noted on the certificate. The Triton 36,000/2 has fundamentally changed our relationship with the ocean by providing safe, reliable and repeated daily access to the most remote and least explored area of our oceans (the Hadal Zone) for the first time in human history. Patrick recently became the second Canadian to reach the bottom of the Mariana Trench and the first person to dive the Challenger Deep twice while accompanied by another explorer. During one of the historic dives in the Mariana Trench, Patrick together with the DNV/GL surveyor, Jonathan Struwe, successfully completed the deepest ever marine recovery operation at 35,840 feet (10,927 meters).



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**Carme Parareda.** Co-founder, administrator and COO of ICTINEU Submarins SL. As a Surveying Engineer she worked in the service of the Cartographic Institute of Catalonia (Government agency) for 15 years, since 1992, in the field of geodesy, high accuracy positioning and GPS navigation techniques. In 2004 she re-oriented her career to ocean observation and underwater technology, co-founding in 2004 the Ictineu Institute, Catalan Submarine Research Centre, and in 2007 ICTINEU Submarins SL where she develops her main professional activity as chief operations manager, sales, certification procedures and DNVGL certified pilot. In parallel from 2007 to 2009 she coordinated the Argo Maris Foundation activities (sea exploration and outreach) and from 2009 to 2016 she was a board member of the Catalan Maritime Cluster. Member of the Marine Technology Society since 2009. A traveller who loves adventure sports and mountaineering, after crossing Mongolia by bike, she sailed across the Atlantic twice. She co-wrote a book, *l'Atlàntic a quatre mans* (The Atlantic four hands).



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As Founder and CEO of *Thorsborg Institute, LLC* and US Merchant Marine Master; Captain Peterson has conducted business in 101 countries directing strategic protocols of intelligence, research, analytical in-situ projects for institutions/agencies, providing options for government resources and evaluation, hydrospace development/training, and intelligence research for global threat analysis. Captain Peterson is an accomplished global intelligence professional, marine biologist; sea captain; underwater archeologist; underwater photographer; advanced/technical scuba instructor; research/scientific diver instructor and dive safety officer who has sailed on commercial and research vessels in all the world's oceans for the past 50 years. He is a member of the Marine Technology Society's Manned Underwater Committee; member of Marine Technology Society's Cybersecurity Committee; member/Dive Safety Officer of American Academy of Underwater Sciences and serves as a member of the National Advisory Committee for the National Sea Scouts.

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**Leonard R. Pool** brings extensive experience in the studying of electronic systems for energy, oceanographic and subsea applications. His past duties include military video systems, extensive active and passive acoustics/sonar applications, the development of medical electronics, defense and subsea requirements for electric robotic positioning, deep water drilling applications and dynamic positioning & navigation. Mr. Pool is the managing director of Sidus Solutions LLC., an electronics engineering company specializing in the development and manufacturing of surveillance equipment for subsea and hazardous areas used in offshore oil & gas operations. His dynamic leadership and innovative engineering has gained him respect and direct relationships with multinational oil and gas corporations, service providers, universities and governmental organizations. Early leadership training as a Naval ROTC cadet eventually led to a 2nd class petty officer in the US Navy. With an affinity of electronics, he became highly skilled in surface and submarine sonar. After his service, Mr. Pool expanded his education, advancing his career in leadership positions of medical electronics before returning to defense electronics, maritime navigation and communication equipment. Mr. Pool has spent the past 20+ years responding to technical demands from energy, defense, academic and industry clients to solve a wide range of surveillance applications.

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**Jakob Sixl** is co-owner of Heinz Fritz GmbH, a family owned company for plastic processing in Germany. He started working in the company beside school since 2003. After finishing his degree in Science engineering at FH Technikum Vienna in 2012, he started to work fulltime for the company. As an all-rounder, he accompanies projects from start to end. Jakob Sixl's specialties are: complex thermoforming of acrylic and CAD design and programming. Since 2018 Heinz Fritz, his step-father, and Jakob Sixl are sharing the ownership for Heinz Fritz GmbH. The passions for extraordinary projects link them well together and keep them motivated to find together solutions for new, sometimes uncommon, high quality products out of acrylic.

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**Mr. Steve Smith** founded ProTek Models in October 2003 with a vision of being the premier supplier of the world's finest quality custom models and prototypes. He started the company out of his parent's garage with little savings and a handful of only the most basic tools and machines. His will and determination to succeed sparked rapid growth within the first few months and the company moved to a 1,500 square foot building in Rancho Cucamonga. Three years later, due to the rapidly growing demand for our models, ProTek Models expanded to a 3,000 square foot building and acquired more machinery and equipment. Today ProTek Models is in a nearly 9,000 square foot facility with nearly 2 million dollars in machinery and equipment. Protek continues to grow as a premier supplier of the world's finest quality models and a growing expansion into high quality, custom manufacturing markets.



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With an engineering degree from Argentina's Merchant Marine University, Alec came to the US in 1992 for graduate studies. He then pursued a career in information technology but continued to feed his passion for all things underwater by designing and building personal submersibles in his garage. He has been diving his own submersibles for over 20 years, and his current sub can carry two people to 1,000 feet. He is also on the crew of Pisces VI, a deep submersible scheduled to re-enter service in 2020. He founded [www.innerspacescience.org](http://www.innerspacescience.org) three years ago to leverage personal submersibles for science on a no-cost basis. In his spare time, Alec teaches an after-school program that combines subsea engineering and marine ecology.



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**Bruce Strickrott** is Group Manager and Senior Pilot of the DSV Alvin at the Woods Hole Oceanographic Institution (WHOI). Alvin, and its support ship, the R/V Atlantis, are owned by the U.S. Navy and operated as part of the U.S. National Deep Submergence Facility, with principal funding from the National Science Foundation and Office of Naval Research. Bruce joined the Alvin operations team in 1996 and has logged over 356 dives for a total time of over 2400 hours (100 days) submerged. Throughout his tenure, he has travelled extensively with the submersible, supporting scientists from around the world with dives to depths of 4500 meters. He participated in several major Alvin overhaul events including the completion of the newest Alvin in 2013. Currently, Bruce has oversight of the engineering and operations groups working on new designs to complete Alvin's final systems conversion for 6500-meter depth certification. Bruce's early career was spent in the service of the U.S. Navy. He has a Bachelor of Science in Ocean Engineering from Florida Atlantic University in Boca Raton, Florida, graduating cum laude in 1996.



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**Jarl Stromer** the Manager of Class and Regulatory Compliance at Triton Submarines, LLC where he works closely with Class societies and other regulatory authorities. He's been responsible for the Classification of fourteen new construction manned submersibles with depth ratings from 1,000 feet to 36,000 feet. Jarl serves on the PVHO standards committee and is a subject matter expert on acrylic plastic. He's been involved in the manned submersible industry since 1986 when he joined the American Bureau of Shipping. His experience is focused in the rules, codes, standards, and statutes governing the design and fabrication of pressure vessels for human occupancy. He holds a degree in Mechanical Engineering from Rutgers University - College of Engineering and is an avid student of the history of manned submersibles. Triton Submarines designs and manufactures the most capable manned submersibles commercially available.

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**Wolfgang Stuber** is the marketing manager for specialty glazing at company Röhm and responsible for the PLEXIGLAS® blocks, used in applications as huge visitor aquarium and pressure windows. He developed the technique to form big hemispheres and is a pioneer of the new art in acrylic manufacturing technology of huge spheres. After his degree in Mechanical Engineering from Technical University Darmstadt, Germany 1988, he started at company Röhm and has had different functions such as the senior engineer for the biggest cast plant in Germany. He has more than 30 years of experience in cast acrylic. Röhm GmbH is a leading supplier of methacrylate chemicals worldwide. Dr. Röhm invented acrylic glass and the brand name is PLEXIGLAS®



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**Roy Thomas** has worked with the American Bureau of Shipping (ABS) for the past 16 ½ years and is currently a Senior Principal Engineer with ABS Global Engineering. He has formerly served as the Manager of the ABS Corporate Chief Engineer's Office and Managing Principal of the Underwater Systems and Lifting Appliances Group. Prior to joining ABS, he worked as a seagoing marine engineer on board oil / product tankers.

Roy is actively involved with various industry committees and currently serves as the Chair of the SNAME T&R Panel OC-6, as well as the Chair of the ASME PVHO - Subcommittees on Diving Systems and Submersibles. He has extensive experience with the certification of underwater units, and has worked as the lead design review engineer at ABS on numerous projects involving underwater vehicles, systems and hyperbaric facilities of every possible form and design. Over the last decade he has played an active role in updating the ABS Underwater Rules and has authored various new sections.

Roy holds a master's degree in Ocean and Naval Architectural Engineering from Memorial University of Newfoundland, Canada, and a bachelor's degree in Marine Engineering from Marine Engineering and Research Institute, India.



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**Jess G. Totten** is a Managing Principal Engineer with the American Bureau of Shipping. Jess has worked for ABS for 10 years and is a subject matter expert on underwater vehicles and systems. Jess graduated from UT Austin with a BS in Mechanical Engineering in 2004. Before coming to ABS he worked a variety of jobs in Houston, ranging from reverse osmosis to pipeline intervention to pizza delivery. Jess was born in Panama City, Panama, is married, and is the father of two children.



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**Matthew Wehner** began his career as a Submarine Officer in the U.S. Navy. He was commissioned through Officer Candidate School in 2002 and entered the nuclear power training pipeline where he completed assignments as a student at Nuclear Power School, Nuclear Power Training Unit, and Submarine Basic Officer Course. In 2004, he reported to USS ALBUQUERQUE (SSN 706) in Groton, Connecticut. During his tour he served in various division officer positions, qualified in submarines, completed the Navy SCUBA Diver course and made two deployments to the Persian Gulf. In 2007, he reported to Naval Special Warfare Group THREE in Coronado, California to serve as the Submarine Operations Officer. During this tour he assisted in the planning and execution of SEAL Delivery Vehicle operations and the initial certifications of the SSGN Lock Out Chamber and Dry Deck Shelter capability.

In May 2009, he left Active Duty, transferred to the Navy Reserve component and affiliated with NR Deep Submergence Unit, where he served as the Intervention Department Head and Operations Officer; and qualified as a Rescue Officer on both shallow and deep water rescue systems, gaining his initial interest and experience in the Submarine Rescue community. As a civilian during this time period, he supported the Naval Special Warfare (NSW) community as an analyst and program manager within the Lessons Learned Program. He mobilized back to Active Duty in the U.S. Navy from Mar 2012 – Jun 2014 to serve as the Operational Support Officer for Naval Special Warfare Group ELEVEN, facilitating reserve support to global Special Operations Forces missions. Upon demobilization, he continued to support the NSW Lesson Learned program as a civilian and served in leadership roles within the Navy Reserves supporting the Theater Anti-Submarine Warfare, Coastal Riverine Squadron and Expeditionary Maintenance mission sets.

He joined the Phoenix International team supporting the U.S. Navy's Submarine Rescue community at Undersea Rescue Command (URC, formerly Deep Submergence Unit) in February 2016 to serve as the Operations Compliance Coordinator and has recently transitioned to filling the role of Contract Manager. He has completed global deployments with the U.S. Submarine Rescue systems in support of training and exercises with international partners in Australia, Chile, Korea, Singapore, Spain, and Turkey, and was also part of the U.S. Submarine Rescue response to the loss of the ARA San Juan off the coast of Argentina in November 2017. As a Navy Reservist, he provides additional support to the Submarine Rescue community, serving as the Commanding Officer of URC's Navy Reserve unit.

Matthew Wehner graduated from the University of Missouri-Kansas City in May of 2002 with a Bachelor of Science in Mechanical Engineering. He is certified as a Lean Six Sigma Black Belt through the University of San Diego, has completed JPME Phase I certification through the U.S. Naval War College, and has earned a Master's of Science in Engineering Management through the University of Southern California



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**Chris Welsh** is a lifelong mariner, licensed captain and submersible operator. Deep Sub LLC owns the DeepFlight Submersible company, the 11KM Challenger submersible, and the mothership Cheyenne with a goal of deep diving worldwide, and two and three-man DeepFlight Super Falcons. Chris is also a pilot with Single Engine, Multi-Engine, IFR, Glider, Seaplane and Helicopter ratings and has flown extensively in the Western United States, Alaska and Baja. He has flown his twin engine plane and his helicopter across the continental U.S.

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Dana Wilkes is the Marine Operations Manager at the National Oceanic and Atmospheric Administration's (NOAA) Office of National Marine Sanctuaries. The Office of National Marine Sanctuaries serves as the trustee for a network of underwater parks encompassing more than 600,000 square miles of marine and Great Lakes waters from Washington state to the Florida Keys, and from Lake Huron to American Samoa. The network includes a system of 14 national marine sanctuaries and Papahānaumokuākea and Rose Atoll marine national monuments. Dana graduated from the U.S. Naval Academy with a degree in Oceanography. He has served in the U.S. Navy as an operations officer. He transferred to NOAA and has had several rewarding positions in the field of marine operations, including executive officer NOAA Diving Program, Dive Safety Officer NOAA expeditions, Operations Manager remote site operations, and Safety manager for NOAA's Submersible operations program. Dana has served on several safety and oversight boards for at-sea operations, submersible safety procedures, and responsibility for developing safe submersible launch and recovery procedures. Dana's career spans over 25 years of experience in at-sea challenges and marine operations for the U.S Government.

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Andy is a mechanical engineer at Woods Hole Oceanographic Institution in Woods Hole, MA. He works on the Alvin manned submersible as an engineer and mechanical technician at sea. Prior to starting at WHOI in 2019, Andy was at Boston University for his Bachelor's in Mechanical Engineering; and has been involved with manufacturing engineering for rocket propulsion systems at Boston University's Rocket Propulsion Group, and SpaceX. Getting ready for Alvin's next major overhaul, Andy has been working on a number of configuration changes including potting of new thrusters.

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**CAPTAIN ROBERT A. WOLF**  
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**Captain Robert Wolf** of Fort Worth, Texas, graduated from the U.S. Naval Academy in 1995 with a Bachelor of Science degree in Systems Engineering. He also holds a Master of Science in Engineering Management from Catholic University of America and Naval Engineer and Master of Science in Systems Engineering degrees from the Massachusetts Institute of Technology.

Upon commissioning, Wolf completed nuclear power training and submarine school and reported to USS KEY WEST (SSN 722) where he qualified in submarines and served as a division officer in engineering and weapons departments deploying twice to the Western Pacific. Wolf then served as an action officer for the Director, Submarine Warfare Division (OPNAV N87) for submarine escape & rescue and Arctic programs. He transferred into the Engineering Duty Officer (EDO) community and completed his EDO qualifications at Norfolk Naval Shipyard where he was the deputy project superintendent for the USS CHARLOTTE (SSN 766) depot modernization period. Subsequently, Wolf served at Program Executive Officer (PEO) Carriers, as the assistant program manager for testing and technical issues for USS GEORGE H. W. BUSH (CVN 77); at PEO Submarines as the executive assistant to the PEO and as the assistant program manager for Post-Delivery VIRGINIA Class submarines; at Supervisor of Shipbuilding, Conversion & Repair in Newport News, Virginia as the Submarine Project Officer and VIRGINIA Class Submarine Program Manager's Representative where he work on 12 new construction submarines, delivering two as well as completing two major submarine repair availabilities; and at Director, Submarine Warfare (OPNAV N97) as the branch head for VIRGINIA Class new construction and in-service submarine hull, mechanical & electrical maintenance and modernization.

Wolf currently serves as the Program Manager for Submarine Escape and Rescue (PMS 391) where he is responsible for advanced development initiatives, acquisition, test and evaluation, in-service support, international engagement, foreign military sales and certification for all undersea escape, rescue and survivability systems for the US Navy.

Wolf has received various personal and campaign awards, including the Meritorious Service Medal with two gold stars and Navy Commendation Medal with three gold stars.

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**Dan Zatezalo** earned his Bachelor of Science of Electrical Engineering with an emphasis in communication systems from West Virginia University. Dan began his career as a field engineer at Sonardyne Inc. before becoming operations manager. During his 10-year tenure, he has gained first-hand experience with Sonardyne's broad technology offering covering navigation, positioning, communication and imaging in the undersea domain. He has since been tasked to further grow Sonardyne Inc.'s US Defense business using his operational knowledge as well as his understanding of the ocean environment.

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