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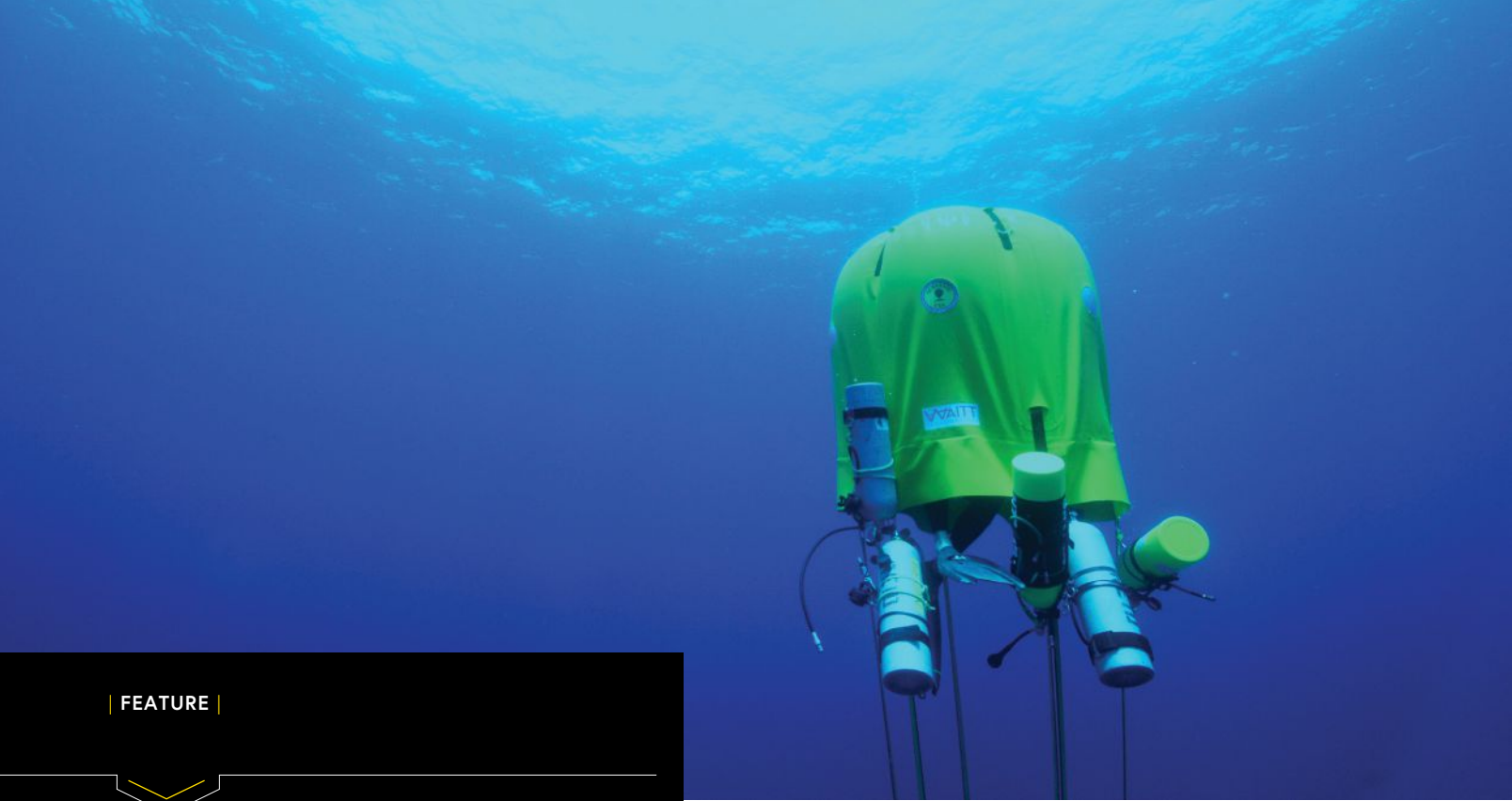
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THE FUTURE OF OCEAN TECHNOLOGY

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| FEATURE |

THE FUTURE OF DIVING TECHNOLOGY



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Diving is inherently technology dependent. Without it, we cannot breathe underwater, and maintaining a breathable atmosphere forms the basis for our ability to enter underwater space and use of our hands and eyes to interpret our work environment in accomplishing a task.

Many may envision pristine reefs, warm tropical breezes, and refreshing cocktails when thinking about life as a career diver. While it might be for some, mostly within the recreational or sporting realm, the reality for the majority of us is a stark contrast. There is a significant community of professionals—often out of the public eye and consequently poorly understood—who spend their very full work days in

» *The Gen 1 Ocean Space Habitat, a portable inflatable underwater tent that puts near saturation diving excursions well within reach for technical diving. (Photo credit: M. Lombardi/National Geographic Society Waitt Grants)*

the dark, both inshore and offshore, immersed in the cold, buried in mud and working with tools to conduct tasks that fill a unique niche—attending to specialized problems that simply cannot be resolved remotely or robotically. These interventions may be as mundane as welding anodes to a sheetpile bulkhead in an industrial waterfront, to as dignified as recovering a body from a sunken vessel, and everything in between. What unifies them is the need for hands, eyes, and spatial awareness to maneuver, interpret, and make critical decisions.

DIVING COMMUNITY INVESTMENT

Interestingly, diving technology (life support in particular) hasn't changed much over the years. Equipment has evolved around the premise of regulating gasses to adequate flows, pressures, and volumes with suitable life sustaining content for the given depth and duration. Then there are added elements for safety and comfort—the ability to verbally communicate, stay warm, and better manage the physiological stress of decompression. The ever-present challenge is how to improve human performance, and this means incremental progress through demonstrated needs to address the many human factors at play within the pursuit of increased depths and/or for longer durations. While diving innovation is exciting, perhaps the most important consideration when implementing new technology is the required level of investment needed in ongoing training, maintaining proficiency, and ensuring a state of community readiness for the unique challenges that lie ahead.

Progress in advancing diving technology today is coming from divergent community sectors, each striving to address their own particular requirements. For example, the sport diving community has significantly advanced closed circuit rebreather technology in the last 20 years,

but this powerful tool is not yet routinely employed within occupational diving fields. Similarly, the offshore community has advanced saturation diving techniques to be highly mobile and not constrained to any specific geographical location, but they aren't employed for the advancement of science, leaving scientific diving tied to very short and shallow dive excursions, with deep access limited to robotic intervention. And then again, there is the public safety community who has evolved lightweight surface-air equipment and associated techniques that could significantly advance other inshore shallow-water sectors if more widely adopted.

TECHNOLOGY CONVERGENCE IS KEY

While technology is evolving in these and other distinct industry sectors, there lacks clear opportunities for the convergence of innovative technologies and techniques given regulatory inefficiencies—both real and perceived. Across the diving community, this results in a quick-to-dismiss culture that hinders the openness to embrace new technology from other sectors. A willingness to engage in cross-sector collaboration and knowledge transfer would provide the impetus for significant diving technology advancement, and benefit us all.

In my own work, I've endeavored to bridge some of these gaps, albeit at small scale, and the results, have shed light on what the future of diving technology may look like. One recent experiment was our development of a shallow water rebreather apparatus and its application to local shellfish harvesting—a technology we often mislabel for deep diving proved to increase daily harvest yields by 20%. Similarly, we applied basic principles of atmospheric management from confined space intervention and saturation diving to put to work portable inflatable habitats for scientific exploration—when coupled with generally accepted deep technical diving, these temporary shelters make it reasonable to spend a full productive work day or more underwater and all without the massive expense of permanent underwater habitats.



With just a very little innovation, we effectively put near-saturation diving excursions within reach for the enthusiast seeking an experience beyond today's conventions. And then there is the value and utility of simply thinking through these types of challenges on a routine basis—having made important investments in life systems integration and associated know-how over the years, we were able to quickly pivot in response to life-saving challenges arising from the COVID-19 pandemic.

SAVING LIVES



» *The Subsalve Oxygen Treatment Hood is an FDA authorized device for treating respiratory distress from COVID-19. It and several supportive apparatuses resulted from a diving technology pivot at the start of the pandemic. (Photo credit: Los Medicos Bolivianos Online)*

In March 2020, amid the ventilator shortage, there were a number of creative responses that stemmed from diving technology and which had a real impact in the form of both PPE and ventilator support. For my group, our response was to rapidly develop and bring to market the Subsalve Oxygen Treatment Hood for helmet non-invasive ventilation—understanding pressures, volumes, and flows coupled with appreciating how to navigate regulatory pathways (US FDA Emergency Use Authorization) similar

to diving regulations presented a perfect storm, warranting our emergency response... diving technology has saved many lives.

This point illustrates the critical importance of diving technology—the culture and community of the working diver is one that has been steadfast throughout history, but also responsive. When the call comes it is more often than not one of emergency, but we're ready—ready to respond, ready to innovate, ready to meet the challenges of today and with the foresight to anticipate and invest in the challenges of tomorrow. Indeed, our own survival depends on it, and will continue so long as we can call our planet 'Blue'.

For more information, about Lombardi Undersea LLC, visit: www.oceanopportunity.com.

» *The RD1 oxygen rebreather developed by Lombardi Undersea LLC. When applied to shellfish harvesting, yields were increased. (Photo credit: M. Lombardi)*