Submariners in Space

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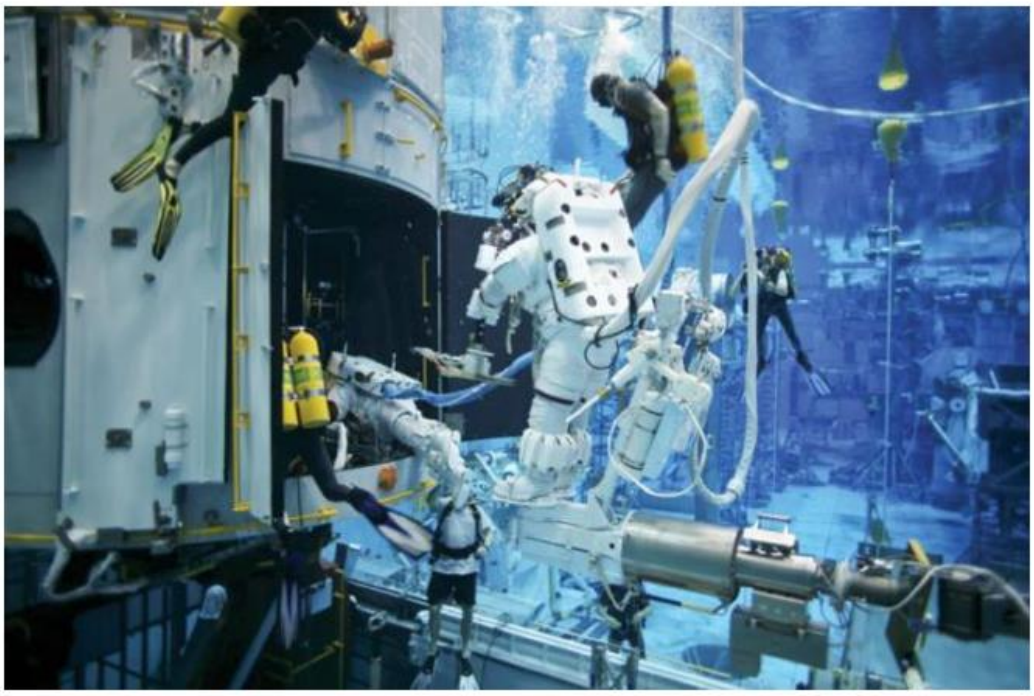
Similarities between navigating deep sea and deep space suggest that divers and submarine sailors would make excellent astronauts.

The Navy's 2016 fiscal budget calls for the continuation of the production of two *Virginia* -class submarines every year, with the promise of the *Ohio* -class ballistic-missile submarine replacement by the mid-2020s. The Navy's submarine force is becoming stronger and is more likely in the near future to meet its numerous challenges. With this expansion comes a corresponding enlargement of a bright and dedicated workforce. In this era of a muffled, yet intense desire for dominance in undersea warfare, another global environment is involved in a similar silent battle. The U.S. government and the National Aeronautics and Space Administration (NASA) are preparing for their second opportunity to gain a scientific advantage in space. The talented personnel needed to operate in such an isolated, challenging environment can arguably only be found among the submarine force.



NASA - NASA uses the Neutral Buoyancy Lab in Houston, Texas, to replicate the weightless conditions astronauts encounter in space. The agency deploys Navy divers to develop underwater training techniques for astronaut candidates.
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Submariners are often said to be much like astronauts, only differing in the unique and often uncharted mediums in which they travel. On 9 March, the U.S. Naval Academy hosted its annual Astronaut Convocation, which gathered five of the

Academy's 52 astronaut graduates to answer questions from the midshipmen in attendance. [1] The astronauts explained that as NASA's vision expands to explore systems beyond Earth's low orbit, more qualifications are considered for aspiring astronaut candidates to stand out among the pool of applicants for each astronaut class. NASA's goal is to explore nearby planets such as Mars within the next quarter century. This objective faces many obstacles, including NASA's current budgetary constraints and a thus-far-elusive solution to the problem of how to reach Mars in a reasonable amount of time. A Mars crew would confront long periods of isolation and psychological and physical complications that may not be fully anticipated or understood by Earth-based research. [2] The correlations between the submariner and astronaut environments could provide key insights into these issues.

U.S. Naval Institute Photo Archive - The 1954 launch of the USS Nautilus, the world's first nuclear-powered submarine, demanded a submariner capable not only of mastering the technological protocols but of dealing with much longer periods submerged in very tight quarters.
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The U.S. submarine force has had a long and storied tradition of producing some of the most proficient individuals in the world. Admiral Hyman G. Rickover is known as the father of the modern U.S. nuclear Navy because of his aim to use nuclear power as the primary source of propulsion for submarines. Formerly, the United States deployed diesel-fueled boats that did not have the endurance to remain submerged for long periods of time. The launch of the USS *Nautilus* (SSN-571), the Navy's first nuclear-powered submarine, prepared the way for boats that could stay submerged for years without refueling or surfacing. (In fact, the

only factors determining a submarine's submersed time are the needs of the crew.) Later, the submarine force also contributed to the nuclear triad by delivering boats that were able to launch strategic intercontinental ballistic missiles. These submarines constantly patrol the world's oceans, providing nuclear deterrence.

Today's submariners face a challenging career. Not only are they a volunteer workforce; officers and enlisted sailors also undergo a rigorous screening and training process that fully prepares them for life under the sea surface.

Earning the Dolphins

Before entering the training pipeline, every prospective submarine officer must not only pass technical interviews at Naval Reactors (the U.S. Navy office that oversees nuclear propulsion in the Navy), but must also be handpicked by the four-star admiral in charge of that office. After these interviews, naval officers head to Naval Nuclear Power Training Command in Charleston, South Carolina, to learn the "theory" behind nuclear power. During these six months at "Power School," submarine officer candidates are immersed in classes on nuclear physics, reactor physics, mathematics, chemistry, and thermodynamics, among others. After they complete Power School, candidates head to another six-month course called "Prototype," where they are tasked with learning to stand watch and qualifying on a nuclear

U.S. Navy (Todd Schaffer) - Submariners and astronauts navigate similiarly cramped, high-pressure environments, depending solely on their respective technologies and expertise for survival and to achieve their missions. A fish-eye lens view captures a conference in the control room on board the USS Helena (SSN-725).
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reactor that once propelled an active submarine. After completing this course, candidates head to Submarine Officer Basic School (SOBC) to learn the fundamentals of becoming a submarine warfare officer. After three months at SOBC, candidates finally go to their submarines to qualify all the required watches and earn the coveted submarine warfare pin, known as the "Dolphins."

Enlisted sailors go through a similar pipeline to the officers except for the Naval Reactors interview and SOBC components. Instead, they undergo more schooling based on their specialty in the Navy. Like officers, nuclear enlisted sailors must relearn the inner workings of the nuclear reactor located in the submarine they are assigned to before they earn their Dolphins.

Transferring Skills from Sea to Space

NASA's Space Shuttle program was often tasked with servicing satellites, repairing telescopes, or delivering payloads to the International Space Station. Shuttle crew usually consisted of a commander, pilots, mission specialists, and flight engineers, each bringing the set of technical expertise of their specific subject areas. Most qualified astronauts have multiple degrees supported by years of research experience. Ever since the space program began, most of the pilots in charge of flying a lunar module, capsule, or shuttle have been military pilots; this bias may never change due to the transferable skills. However, astronauts should not only be experts in their specific fields: They must also be able to adapt to an unfamiliar environment that will have dynamic problems. This situation is familiar to submariners and other military personnel who face similar problems that demand adaptation in their daily duties. Submariners face the anxiety of literally drowning in their workplace if challenges are not immediately understood and solved. Nuclear reactors on board submarines are operated with numerous safety protocols that must be followed to the letter to prevent a nuclear catastrophe. Submariners endure numerous drills, including fire drills and reactor safety plant drills, to test the capabilities of each individual to operate together as a fully functional crew. They also often face problems that require immediate critical thinking, with deadly repercussions for even a single mistake. A nuclear-submarine crew navigating underwater faces its own set of risks and complications, just as a crew of astronauts does while performing a mission in

space. Like astronauts, submariners must count on their training from the initial pipeline to overcome these obstacles.

With NASA and other private-sector agencies currently investigating the idea of fueling rockets and space-based vessels with nuclear reactors, nuclear power offers the promise of sustainability and independence. If nuclear reactors are the answer to reaching beyond our solar system, then qualified submariners provide the best background in training and knowledge to fit the job profile of exploring distant worlds.

The project of establishing a more local "base" would solve numerous difficulties presented by space travel, because the biggest problem is that of the human psychological toll caused by long-term space flight and isolation. Here again the experience of submariners is relevant. NASA has determined that to successfully return to the moon for an extended period and to explore Mars, these behavioral and psychological effects must first be studied. Since astronauts not only spend "more time confined in the spacecraft," but also "[live] in an environment that is fraught with potential danger," the effects of isolation may be amplified. [3] The Behavioral Health and Performance Element of the NASA Human Research Program is tasked with managing three risks, including risk due to behavioral and psychiatric conditions. A study reports that "34 behavioral signs and symptoms were reported among the 208 crew members who flew on 89 shuttle missions from 1981 and 1989, spending a total of 4,442.8 person-days in space." This correlates to an "incident rate of 0.11 for a 14-day mission." NASA has been conducting human behavioral research on "ground-based analogs, such as those in the Arctic and Antarctica or undersea habitats."

Although these observations are not similar to space-flight observations, they still provide insight into what qualities to prioritize when interviewing prospective astronaut candidates. Submariners are typically underwater three to four months at a time, operating in stressful situations and isolated from their families. "For submariners, the incidence of psychiatric disorders that were severe enough to result in either the loss of a work day or the need to be medically evacuated ranged between 0.44 and 2.8 per person/year." It is true that submarines have larger crews and berthing requirements compared with those of modern spacecraft. Regardless, submariners would make good astronauts for missions that require long space flights because of the similar psychological conditions that

both present. We may still be far from understanding the full effects of long-term space travel on the human mind and body, but studying the effects of long-term isolation and underwater deployment on submarine crews and sending submariners to space are good places to start.

NASA - Submariners and astronauts navigate similiarly cramped, high-pressure environments, depending solely on their respective technologies and expertise for survival and to achieve their missions. NASA astronaut Scott Kelly reclines in a Soyuz simulator at the Gagarin Cosmonaut Training Center in March in preparation for a launch to the International Space Station.
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The latter idea is not a new one. Captain Stephen Bowen, a 1986 U.S. Naval Academy graduate and former executive officer of the USS *Virginia* (SSN-774), was selected as a mission specialist for STS-126. In an interview for *Undersea Warfare* magazine, Bowen claimed that "the living conditions on the space shuttle are very similar [to that of] living on a fast-attack submarine." [4] He also mentioned that on both submarines and the shuttle, one "learns how the equipment should operate, how to operate the equipment in many conditions and situations . . . and if something goes wrong or if something should change, [one has] the ability to understand, adjust, and get the job accomplished and continue to operate." Bowen confirmed that the intense level of training required to become a mission specialist is similar to that for a submariner. Even before his experience, NASA had sent an enlisted submarine-qualified sailor-turned-test pilot, Astronaut Michael J. McCulley, into space. Before attending college and receiving a commission through an NROTC program, McCulley served on board one diesel-

powered and two nuclear-powered submarines. After becoming a test pilot, he was the pilot on STS-34, part of the crew on board the shuttle *Atlantis* .

Space Divers?

In addition to sending submariners, NASA has sent several Navy diving officers to space. NASA tries to simulate the feeling of weightlessness that astronauts feel in space by putting them in an enormous tank of water. Although astronauts still feel the drag of their suits and the gravitational pull of the Earth while in the water, "neutral buoyancy" comes very close to replicating weightlessness in the Neutral Buoyancy Laboratory (NBL) at the Johnson Space Center in Houston, Texas. A Navy diver's career deals with salvage operations and mine disposals that require years of training and experience, both of which can mimic the effects of space. In fact, the facility at NBL is named after Captain Manley "Sonny" Carter Jr., a Navy diver who developed underwater training techniques for future astronaut candidates.

The U.S. submarine force and Navy divers share a unique relationship. Submarines carry one diving officer and a handful of Navy divers for every boat in the fleet. The diving personnel on board are also submarine-qualified and have the unique job of swimming "security sweeps" when a submarine pulls into port. Another famous diving officer connected with NASA is Captain Laurel Clark. Before becoming a NASA flight surgeon, Clark completed training with the Diving Medicine Department at the Naval Experimental Diving Unit and was then assigned as the Submarine Squadron Fourteen Medical Department Head after qualifying as a submarine medical officer. Although Clark never served on board a submarine, she understood the psychological reactions that come with working in close quarters for an extended period of time. Because of her expertise in this matter and being a diving officer by trade, NASA selected her to go to space.

Submariners have a unique opportunity to become dive-qualified in the Navy because of the close relationship that exists between both communities. Astronaut candidates who are not only submarine-qualified, but also dive-qualified, can further enhance NASA's agenda of reaching Mars in the near future by cutting down the training required for chosen candidates.

The sailors of the U.S. submarine force have proved their resilience in the past, as they battled the Nazi U-boats of World War II, covertly hunted the Soviet Union submarines during the Cold War, and have since conducted strike and intelligence, surveillance, and reconnaissance missions in support of U.S. special operations forces. To this day, they remain the most technically proficient and capable workforce, always ready to face any challenge. NASA does not need to look further when considering prospective astronaut candidates for a mission to Mars or beyond.

Submariners are the future of space research. Qualified submariners will thrive as astronauts because of the similarities in the space and undersea environments. The technical and psychological experience needed to become a submariner can easily be transferred to fulfill most of the qualifications of a flight-ready astronaut, allowing for more streamlined training. However, submariners know better than to label environments like the depths of the ocean and the outer reaches of space as "final frontiers." Whether they'll be navigating in deep sea or deep space, the exploration is just beginning.

1. Tyler Caswell, "USNA Hosts Annual Astronaut Convocation," U.S. Navy press release, 10 March 2015.

2. Charles Q. Choi, "Manned Mars Missions: How Will Astronauts Cope?" Space.com.

3. K. Slack et al., "Risk of behavioral and psychiatric conditions," *Human Health and Performance Risks of Space Exploration Missions, NASA SP-2009-3405* , (Houston, TX: National Aeronautics and Space Administration, Lyndon B. Johnson Space Center 2009), 5.

4. Molly Little, "A Submariner in Space," *Undersea Warfare: The Official Magazine of the U.S. Submarine Force* , Winter 2009.

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