Other academies

Other states' academies have more modest aims. "Most of our work effort involves conducting studies or projects on behalf of state agencies or the general assembly," says Richard Strauss, executive director of the Connecticut Academy of Science and Engineering. The legislature provides the academy with enough funding to conduct about one study each year, he says. One previous topic was indoor air quality in schools. The academy also reviews grant applications for the state's own biomedical research and stem-cell programs.

In addition to its National Academies members, the Washington State Academy of Sciences elects members by nomination and evaluation, says executive director Robert Bates. The 120-member academy originally hoped to emulate the National Academies model of conducting studies commissioned by the state government, but it soon found that agencies had little money available. Instead, it receives enough money from the legislature to support about one study each year. The academy is just finishing up an assessment on the causes of root rot that is decimating Douglas fir trees.

The Vermont Academy of Science and Engineering's attempt to follow the National Academies' advisory model "has been only modestly successful," says Christopher Allen, its past president. Although the academy has had major input to legislative discussions of climate change, it has otherwise been in little demand from the state government for its advice. As a result, the academy recently refocused its work to support science, technology, engineering, and mathematics education. It offers awards to STEM teachers and grants so they can buy small equipment to develop projects outside the classroom.

David Kramer

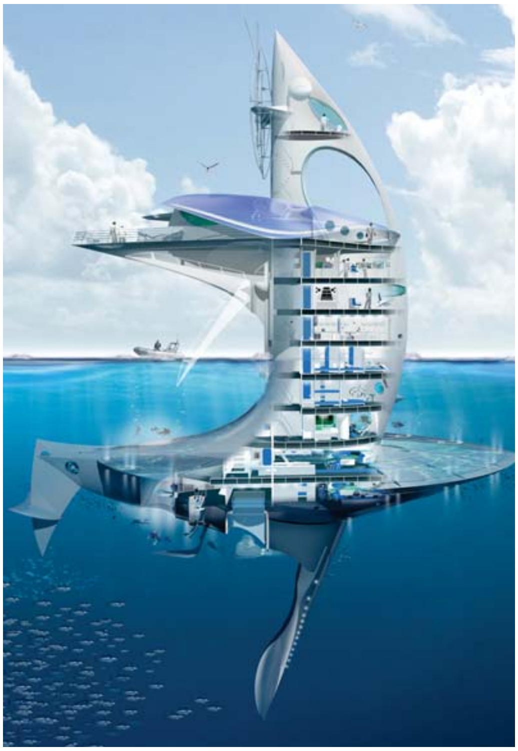
Proposed sea vessel offers science on the drift

Half ship, half submarine, the 58-meter-tall *SeaOrbiter* aims to simultaneously be a floating laboratory, a hangar for underwater vehicles, and a training base for aquanauts. Based in France, the project has a specific objective to "enable [researchers and explorers] to live underwater for long periods of time," says oceanographer Ariel Fuchs, executive director of the project. The oceanic research and exploration vessel took more than 12 years to plan. Construction is scheduled to begin this spring and, including integration of the initial scientific and communications equipment, is expected to cost \$52 million and take 12 to 18 months. The maiden voyage—from Nantes near the Atlantic coast of France to Monaco on the Mediterranean—is scheduled for the spring of 2016.

The project is sponsored by a mix of commercial and other nongovernmental partners from around the world and managed by experts from the ocean- and space-exploration communities. *SeaOrbiter* can accommodate up to 22 crew members, who will rotate every three to four months. Annual operation costs are estimated at \$3.4 million. An international scientific committee led by physicist Charles Kennel, director emeritus of the Scripps Institution of Oceanography, will be responsible for choosing and prioritizing the vessel's scientific missions and instrumentation.

Fuchs concedes that the project, whose partners include watchmaker

SEAORBITER/JACQUES ROUGERIE



From above and below the waterline, *SeaOrbiter* will give scientists firsthand access to the ocean–atmosphere interplay.

Rolex and defense contractor European Aeronautic Defense and Space, faces a "struggle against skepticism, [particularly] from French academics who have differing visions and who don't necessarily appreciate the politics of privately sponsored science expeditions." And few potential private partners want to "invest in an adventure that is so exploratory, scientific, and educational," he adds.

Attracted by the Eye

The brainchild of French architect and ocean explorer Jacques Rougerie, *SeaOrbiter*'s design places 6 of its 10 levels, including all living quarters, below the waterline. The underwater levels also include a hangar for autonomous and manned underwater vehicles. The pressure of the lowest level, 12 meters below the waterline, can be adjusted to match deep-sea pressures. That feature allows deep-sea explorers and astronauts simulating space exploration to live for prolonged periods at deep-sea conditions and avoid the health risks of returning too quickly to atmospheric pressure.

Situated above the waterline are avian- and marine-life observation decks, meteorological instruments, and multidisciplinary research labs. Near the top of the vessel is *SeaOrbiter*'s "Eye," a lookout post and public communications platform. At the end of last year, the project team launched a crowdfunding campaign to raise €325 000 ($440 000) to fund the Eye's construction. Fuchs says the campaign's goals are to attract both additional funding partners and the public's interest.

Like unmanned research buoys moving on the ocean current, *SeaOrbiter* can "operate in drift mode," quietly conducting science with minimal disturbance to its environment, says *SeaOrbiter* operations director William Todd, who also leads the NASA Extreme Environment Mission Operations program. The vessel's energy demands will be provided by a wind turbine, a solar panel, wave-energy converters, and algae-based biofuel generators.

Sea-level climatology

SeaOrbiter will be outfitted with active and passive acoustic and optical instrumentation and other sensors to measure the ocean's physical properties. (For more on ocean sensing, see the article by Tom Sanford, Kathie Kelly, and David Farmer in Physics Today, February 2011, page 24.) Much of the science will be focused on "climate problems and issues of global warming on the ocean," says Fuchs. Scientists aboard *SeaOrbiter* can continuously measure such air–ocean interfacial properties as CO_2 concentration, marine-aerosol concentration, and heat and gas flux. According to a report written by the Kennel-led science committee, such data can supplement oceanographic-satellite and research-buoy observations used to model the climate and the global carbon cycle. Other investigations envisioned for *SeaOrbiter* include physiological and psychological studies of aquanauts and ocean-floor mapping for mineral exploration.

"During the 1960s, both space and our oceans were seen as the new frontiers for exploration," says NASA oceanographer Gene Carl Feldman. He has conducted historical research on the *PX-15*/*Ben Franklin*, a privately sponsored research submarine whose mission, led by Swiss deep-sea explorer Jacques Piccard, coincided with, and was largely overshadowed by, the *Apollo 11* Moon-landing mission. "My hope is that *SeaOrbiter* can help rekindle the dream of long-term exploration of our oceans," Feldman says.

Jermey N. A. Matthews

US output of critical medical isotope to begin this year

Striving to eliminate the use of highly enriched uranium (HEU) in production of the world's most widely used medical radioisotope, the Department of Energy in November awarded $10.9 million to NorthStar Medical Radioisotopes to produce molybdenum-99. The Wisconsin company will, ironically, use one of the last remaining HEU-fueled nuclear reactors in the US to make the product. HEU, which is at least 20% ^{235}U, is considered to be a proliferation risk because it is an important step toward producing nuclear weapons–grade uranium, usually defined as 85% or greater ^{235}U.

The US has no domestic source of ^{99}Mo, whose decay product, metastable technetium-99, is used in 16 million US medical procedures annually. Most of the world's output of the short-lived isotope is produced in a few research reactors in Canada and Europe that use fission targets enriched to 93% ^{235}U. A South African reactor has been partially converted to use low-enriched uranium (LEU) targets. DOE's National Nuclear Security Administration (NNSA) has been paying NorthStar and four other US companies to develop production technologies for ^{99}Mo that don't require HEU.

NorthStar is developing two non-fission-based approaches to isotope production. One technology, in which a neutron is captured by ^{98}Mo, is being pursued in collaboration with the University of Missouri, which operates an HEU-fueled research reactor known as MURR. The other process will use gamma rays provided by an accelerator to transmute ^{100}Mo through emission of a neutron. The NNSA's Global Threat Reduction Initiative (GTRI) has provided $4 million to support development of NorthStar's accelerator technology.

Jim Harvey, NorthStar's chief science officer, says that production at MURR will commence in mid 2014, pending Food and Drug Administration (FDA) approval, at an initial rate of 100 six-day curies per week. A six-day curie is the number of curies remaining in a shipment of ^{99}Mo six days after it leaves the producer's facilities. The half-life of ^{99}Mo is 66 hours. Capacity of 3000 six-day curies per week is expected to be attained at MURR in late 2015, depending on demand. That output should satisfy half of projected US demand for the isotope, he says.