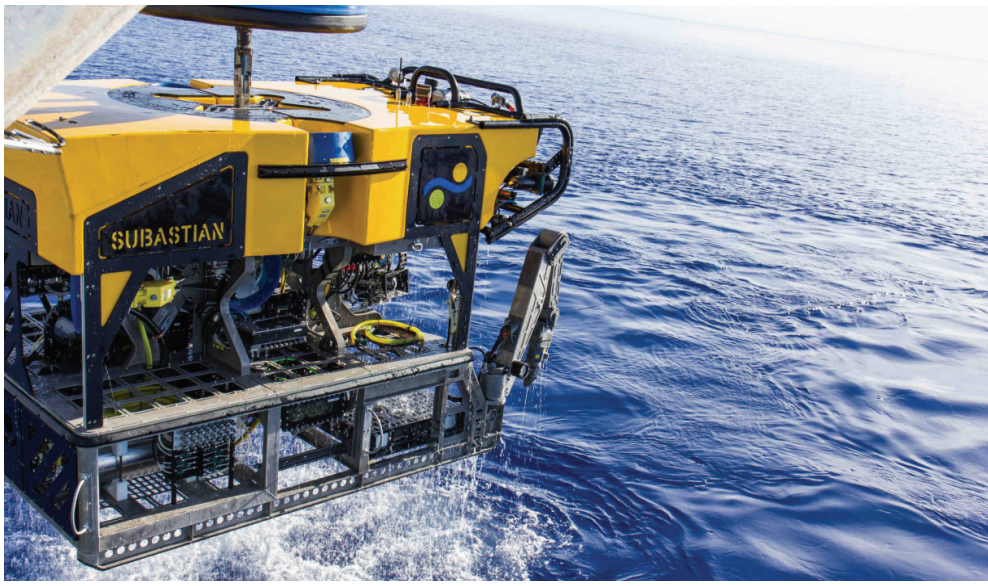
SuBastian and the Roboats

Jesse H. Ausubel

After I was hired at The Rockefeller University, I was sent to talk with the President Emeritus. After I babbled for a while about environment, he turned to me and said, "Just remember, there is no reason to do anything trivial here." That is the basic guidance for the 2016 National Ocean Exploration Forum: do not do anything trivial.

Our point of departure is respect for the achievements of the engineers among us, and their peers. They present SuBastian and the Roboats. SuBastian is not the lead singer of an indie rock band but a superbly capable autonomous undersea vehicle (AUV) developed by the Schmidt Ocean Institute. The Roboats are not back-up singers and musicians but robotic floats, autonomous surface vessels (ASVs), which navigate the canals of Amsterdam. SuBastian and the Roboats exemplify the theme of the Forum, Beyond the Ships.

Of course we love ships, and I personally have had marvelous experiences aboard the E/V *Nautilus* and the E/V *Okeanos Explorer* and heard many direct reports of excitement on the *Falkor, Alucia,* and other vessels as well.



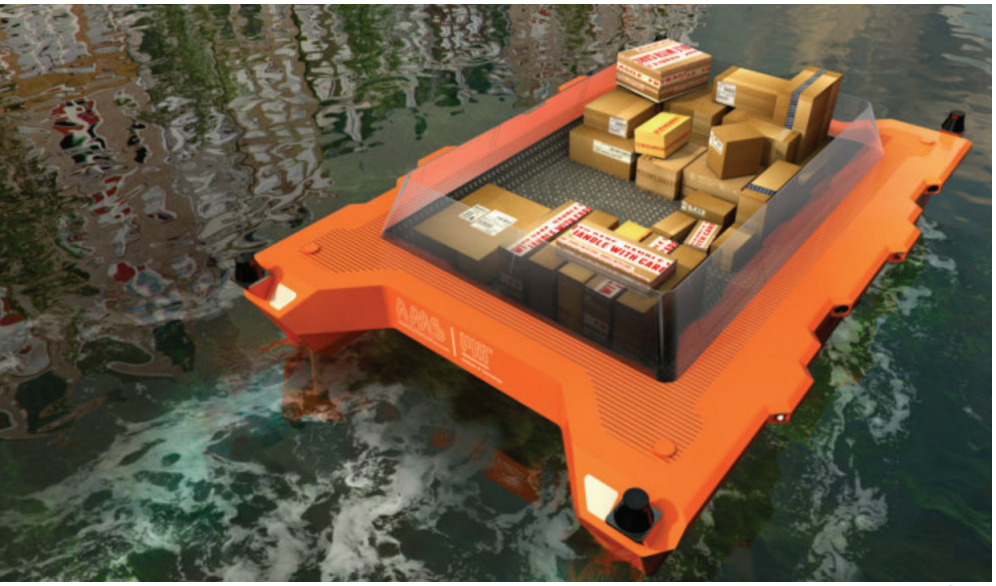
SuBastian

Nevertheless, to fulfil our charge to envision ocean exploration during the interval of 2020–2025, we must consider the new vocabulary overtaking many domains of our life. Think of Uber, GPS, and self-driving cars. Think of satellite farming, precision agriculture, and pervasive distributed sensors that allow a farmer to know the moisture needs of each square meter of his fields. Think of IBM's Watson computer now doing medical diagnostics. Think of the so-called Revolution in Military Affairs emphasizing reconnaissance, robotics, and precision force. Think of Siri and Echo and voice-activated devices diffusing in our homes, offices, and mobile devices. Think of binge-watching, clickbaiting, and netiquette.

All of these associate with autonomy, sensors, precision, miniaturization, and machine learning and artificial intelligence. Bandwidth. Drones. Telepresence. Cyberspace and meatspace. They associate with better forms of energy storage and, increasingly, with sharing to boost asset utilization. The adjectives modifying the concepts tend to be words like smaller, lighter, faster, denser, cheaper, and virtual. At the same time they benefit from economies of scale and can form huge integrated systems, eased by better information handling.

The new vocabulary signals that we are entering a world of farming without farmers, flying without pilots, and sailing without sailors. This will be the world of the 2020s, and ocean exploration must adapt and adopt, and should innovate too. It will be the world of SuBastian and the Roboats.

Early in October 2016 I attended Japan's biennial marine technology expo, Techno-Ocean, in Kobe. I asked our Japanese counterparts what differs from a generation or two ago. One answer was simple and consistent. During the 1950s and 1960s Japan built ships to help rebuild its industrial structure. A generation ago Japan still competed aggressively to



A Roboat

build ships. Much of a comparable earlier expo would have related to ship technology and competition with Korea, China, and other shipbuilders. Now Japanese firms see potential growth and profit in other kinds of marine technology. The markets for these span offshore exploration and production of oil and gas, possibly exploitation of other seafloor minerals and ocean energy, tourism, environmental protection, science, and national security.

In Kobe the firms, not only Japanese, showcased autonomous surface vehicles, like the Roboats; autonomous undersea vehicles, including those that can hover and can follow complex mid-water routes, of many sizes, capacities, and endurance, like SuBastian; autonomous and remotely operated cameras, from small to large; passive acoustic devices to listen to marine life (the discussion paper by Jennifer Miksis-Olds and Bruce Martin offers a far-sighted look at this field); active acoustic devices and 3D acoustic video cameras to sound out marine life, shipwrecks, and other objects; new devices of several kinds, some autonomous, to swath map the seafloor; devices for depth profiling operable with little deck space and without electric power sources; and gliders that use small changes in buoyancy to convert vertical motion to horizontal and thereby propel themselves while consuming minimal power.

Inevitably, future marine technology exhibitions will also showcase more life technologies and biological sensing, the subject of Shirley Pomponi's discussion paper. As host, I take the prerogative to share the success of my colleague Mark Stoeckle with naked DNA in seawater, eDNA, shed by resident or passing organisms. In the East River right next to where we meet on The Rockefeller campus, Mark collects small bottles of seawater and filters it for eDNA. The results are astonishing. Without capturing or photographing the animals, we know the fish species that live nearby. When Mark measures eDNA month by month, we get dynamic results superbly consistent with data obtained by traditional surveys at great cost. The levels of DNA present even seem to index abundance.

The power of eDNA makes us wonder what the future of biodiversity surveys might look like. Will it be a traditional vessel with nets and fish-finding sonars? Or, will it be a small drone, an autonomous aerial ecologist, that can lower empty vials into the ocean to catch a little water with DNA?

To scout smartly underwater, Forum participant Yogesh Girdhar of the Woods Hole Oceanographic Institution already builds small curious swimming robots, the size of an attaché case, that learn as they

swim and can efficiently explore a coral reef like an experienced scuba diver but without the needs of a human diver.

Let's also think during the next two days about what we could do collectively, how we might mount campaigns together, for example, in the Arctic, Gulf of Mexico, and South East Atlantic Bight. Let's advance ways we might share data, whether from geology or maritime history, to create eye-opening resources that might engage many millions of people. In each campaign we plan, let's think critically about public engagement, as Jerry Schubel's hard-hitting discussion paper emphasizes.

The technical change will force or stimulate change in the organizations, institutions, and programs in which ocean explorers operate. Cameron Hume's discussion paper reminds us that a necessary part of our task during the Forum is also to stimulate an update of the vision of our institutions and how we operate.

Former Assistant Secretary of the Navy, Robert Frosch, who also served as Administrator of NASA, used to object to the so-called Precautionary Principle, promulgated by some regulators, as tantamount to "Don't do anything for the first time." Bob rightly emphasized the importance for evolution and learning of the antithesis, doing things for the first time. For me, that is the essence of Exploration. It is precisely about the thrill and value of doing things for the first time.

During the Forum, let's think imaginatively about doing a bunch of things for the first time. Let's not do anything trivial. Take seriously the ambitious aim of mapper Larry Mayer for a high-resolution General Bathymetric Chart of the Oceans (GEBCO) to guide and ease the work of all explorers and many others at sea. Take seriously the exhortation of Mark Hannington and Sven Petersen in their informative and inspiring discussion paper on marine minerals to initiate a Global Geological Survey of the Oceans and transects or traverses that can demonstrate its feasibility.

I hope by now it is clear that the 2020s will not be a world of exploring without explorers. On the contrary, there will be many more explorers, but we and our diverse prostheses will play new roles. Let's adventure with SuBastian and the Roboats.

Thank you.

A shorter version of this essay appeared as the editorial "SuBastian and the Roboats: Ocean Exploration's Future" in *Sea Technology* v58 No 1 p. 7, January 2017. (link)