The Machine in Neptune's Garden

Historical Perspectives on Technology and the Marine Environment

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Science History Publications/USA
2004

First published in the United States of America by
Science History Publications/USA
a division of Watson Publishing International
Post Office Box 1248, Sagamore Beach, MA 02562-1248

www.shpusa.com

Library of Congress Cataloging-in-Publication Data
The machine in Neptune's garden : historical perspectives on technology and the marine environment / Helen M. Rozwadowski and David K. van Keuren, editors.
p. cm.
Includes bibliographical references and index.
ISBN 0-88135-372-8 (alk. paper)
1. Oceanography,Technicalogical innovations—History—Congresses. 2. Oceanography—History—Congresses. I. Rozwadowski, Helen M. II. Van Keuren, David K.
GC28.M27 2004
551.46'028'4—dc22

2004045260

Designed and typeset by
Publishers' Design and Production Services, Inc.

Printed in the USA.

CHAPTER 10

Engineering, Imagination, and Industry

Scripps Island and Dreams for Ocean Science in the 1960s

HELEN M. ROZWADOWSKI

INTRODUCTION

The oceans in the 1960s represented one of the last frontiers for humanity. One popular writer, Seabrook Hull, declared, "This is the successful scaling of Mount Everest, the hewing of modern America from virgin wilderness, and the yet-to-come exploration of the Moon all rolled up into one."[1] The possibilities seemed limitless. The seas offered a host of valuable resources ranging from food to minerals to drinking water to direct undersea shipping routes to living space. Most of these would be found on the continental shelf, not in the deep ocean basins. Taking advantage of these resources would require a partnership of exploration, engineering, and science. Indeed, the plethora of explicit comparison between outer space and "inner space," as oceans were dubbed, derived from the fact that humans required the mediation of technology simply to survive in these places, much less to explore and exploit them.

The post World War II period saw the rapid expansion of ocean sciences, including the creation of new institutions, technologies, and sub fields. This growth occurred in many countries but had a strong Cold War dimension. In the post-Sputnik United States, proponents of ocean exploration stressed the Soviet submarine threat in their arguments to expand marine sciences on all fronts. In 1959, the National Academy of Sciences (NAS) Committee on Oceanography, appointed two years earlier, recommended to the government a decade of intensive expansion of the field, to be funded jointly by military and civilian agencies. While before the war only two institutions had become major centers of marine science, by 1966 at least fifty colleges and universities offered degree programs in oceanography, marine biology, and ocean engineering. The pace of growth accelerated during the mid 1960s and remained breakneck through the early 1970s.[2]

Oceanographers who urged the dramatic extension of their field predicted with confidence an equally speedy growth in an oceanic industrial sector. Instead, undersea farming developed quite slowly, and industry still finds it unprofitable to mine most minerals from the seabed or seawater. From the perspective of the 1960s, however, observers anticipated the inevitable and speedy inauguration of new modes of travel, recreation, work, and life undersea. This chapter studies a research facility known as Scripps Island, which represented to its designers at the Scripps Institution of Oceanography the epitome of future uses of the sea. The facility, an artificial island to be constructed a mile offshore and connected to the beach by a causeway or pier, was primarily intended to support basic science, particularly in the fields of marine biology, ecology, and physiology as well as biological geological, and physical and chemical oceanography. In addition, it would link Scripps Institution of Oceanography to a new medical school being developed at the University of California, San Diego (UCSD), because of anticipated growth of hyperbaric medicine accompanying experiments with underwater habitats such as Sealab in the United States and Jacques Cousteau's Conshelf program. The Island would, then, represent a major investment in "Man-in-the-Sea" research, a term adopted by both naval and civilian agencies pursuing undersea exploration by humans. Finally, the structure itself would serve as a model for appropriate ocean engineering, combining aesthetics with minimal environmental impact on local beaches and seafloor in a multi-use facility. Much of this work stood far afield from the familiar territory of most Scripps researchers, but planners expected the Island to serve ocean science for its next 50 to 100 years of development. They also hoped to offer an example of engineering useful to many branches of oceanic industry, notably oil drilling and recreation. Scripps Island would, in short, provide a model for coastal zone development that balanced the interests of science, industry, and the public.

The vision of oceanography embedded in Scripps Island has not come to pass. This chapter explores an episode of oceanography's history that proved a dead end. Decline or abandonment of technologies and technological systems, as well as false starts, can offer insights that would be lost by studying only the establishment of those technologies that we currently use.[3] Historians of science who investigate scientific fields such as oceanography that attempt to comprehend vast, remote, or inaccessible environments, would do well to take this advice to heart. Scientists' understanding of the sea is strongly mediated through technology, so historians of oceanography should address not only intellectual, social, and political dimensions of this enterprise, but also technical dimensions.[4] Doing so, as this chapter suggests, emphasizes aspects of oceanography that are not well represented by existing historiography, namely the importance of public interest, non-military patronage, industry involvement, and participation of investigators who were considered unwilling or unable to brave the surf zone to gain access to the undersea environment.

This chapter studies the design and planning of Scripps Island with the aim of elucidating the relationship between technology and the evolving understanding and use of the ocean environment from the 1950s through the early 1970s. One way to approach this problem might be to examine how technology influenced scientists' growing understanding of the sea. For example, one could investigate the rise of scientific diving to see if adoption of scuba technology had a profound or lasting effect on oceanography, as many of its early advocates predicted. Or, perhaps, scuba's development was influenced by the growth of oceanography. Scripps Island plans grew, in part, out of enthusiasm generated by staff members who pioneered scientific diving. Rather than select one technology for examination, however, this chapter looks at the intricate technological system that was to be Scripps Island. Instead of trying to trace specific ways in which technology shaped emerging knowledge of the ocean environment, I look at how enthusiasm for undersea exploration, in conjunction with its attendant technology, inspired oceanographers to consider re-orienting their science in ways that would have had a profound effect on how people defined and utilized the sea. The Scripps Island plan was predicated on the assumption that the ocean's resources should be comprehensively exploited. When the idea was initially conceived, its proponents perceived the sea as a vast frontier whose resources were virtually inexhaustible. The end of the story, however, was strongly influenced by the growth of the environmental movement, which tempered the rhetoric of the frontier to include acknowledgment of the ocean as an arena in which to apply lessons learned from misuse of terrestrial resources. Critics went even further than that, to condemn the whole project as a potentially tragic despoliation of the coastal zone.

SCIENCE, TECHNOLOGY, AND OCEAN RESOURCES IN THE 1960S

Sputnik not only touched off a space race, but also galvanized Americans to improve science and engineering more generally. With the threat of Soviet nuclear submarines, oceanography received special attention from scientists and popular writers in the late 1950s and throughout the 1960s. Among experts, discussion revolved around reports by the Navy and by the National Academy of Science's Committee on Oceanography, both of which appeared in 1959.[5] While physical oceanography was most relevant for supporting naval warfare, these reports urged a dramatic expansion in funding to all areas of ocean science, with the Academy committee proposing for the decade from 1960 to 1970 a doubling of basic research accompanied by support for extensive ocean-wide surveys and applied marine sciences.

Besides national security, there appeared to be many compelling reasons to boost knowledge of the oceans. Under titles such as *The Bountiful Sea* and *Riches of the Sea*, scientists and popular writers enumerated the living and non-living resources available for human use in the near future, when they expected technology to have advanced sufficiently to enable economical use of plankton for food, manganese nodules, and desalinized water. Predictions included massive increases in fish harvesting, the possibility of mining minerals directly from seawater, and the construction and operation of underwater oil drilling systems by divers living in underwater habitats. Diving also opened new recreational access to the sea, at a time of rapid coastal development and the associated rise in popularity of boating, surfing, sport fishing, and other marine activities. In 1966, legislation was introduced that aimed to establish Sea Grant institutions of higher learning, using the analogy of land-grant colleges. As originally proposed, a major goal was to generate income for educational institutions by promoting the use of submerged resources on government-controlled offshore lands. Even what seem like the wilder speculations, such as installing nuclear reactors on the ocean floor to generate circulation of nutrient-rich bottom water to the sunlit surface (to create artificial upwelling zones), were seriously proposed as pilot studies for the near future by the NAS Committee's report.[6]

Although people worried about undersea warfare and welcomed news of riches from the sea, the popular appeal of the oceans lay in their characterization, by scientists and others, as a frontier. Roger Revelle described the post-war era of oceanography as "one of the great ages of exploration. You could hardly go to sea without finding something new."[7] Most oceanographers felt this way. Those promoting the expansion of their field in the late 1950s and early 1960s employed the rhetoric of the frontier, as the opening quote attests. Richard Vetter, who served as the executive secretary of the NAS Committee on Oceanography, edited *Oceanography: The Last Frontier*. Oceanographer and naval officer Captain E. John Long wrote an introduction to the science titled *New Worlds of Oceanography*. Popular writers quite naturally seized this image and developed the analogy to peopling the western frontiers. One of the more fanciful among them, Arthur C. Clark, narrated a visit to an undersea resort that he imagined in business within the 1960s. "Everyone who goes underwater becomes an amateur scientist," Clark declared. Guests at the underwater hotel on a coral reef would don scuba gear and, with a wave to those watching from underwater observation windows, follow their guide on an excursion to see and interact with spectacular marine creatures and to use novel propulsion devices to range far from the hotel. Perhaps it will come as no surprise that the introduction to Clark's book was penned by Wernher von Braun, the German rocket engineer who, after the Second World War, imported ballistic missile technology and worked on the American space program.[8]

As with space exploration, technology and engineering enjoyed center stage in dreams for future uses of the ocean. In 1960, the same year as Clark's book, the bathyscaph *Trieste* reached the bottom of the Marianas Trench in southwestern Pacific, the deepest point in all the oceans, nearly seven miles down. Although the Navy sponsored this accomplishment with the stated intention of beating the Soviets there, the project leader, Scripps scientist Andreas Reichnitzer, and others insisted that the goal was to get the record-breaking out of the way in order to concentrate on science.[9]

In the early 1960s, several companies developed deep-diving submersibles for applications including science, salvage, and oil drilling. Oil provided the most immediate prospect of profit. While in the 1960s only eight per cent of the world's oil came from the sea, five years later that percentage was almost doubled. In 1966, seventeen countries produced offshore oil, but fifty were exploring off their shores. Engineers acknowledged the importance of submersibles for the oil industry, but most were convinced that the need for human divers would grow in step with the industry. Scientists, too, insisted on the benefits of bringing the trained biologist or geologist into the sea. The twin goals of getting divers to greater depths and keeping them there long enough to do useful work touched off the pursuit of devices and techniques such as mixtures of oxygen and other gasses to avoid nitrogen narcosis.[10]

Scripps Institution was deeply involved in pursuing these new dreams for exploring the oceans and exploiting their resources. Indeed, Scripps of the 1950s took a lead in creating the template for oceanography of the future. Its long-time director Roger Revelle, who headed the institution from 1948 to 1964, was often called a statesman of science. He numbered among the leaders of international and national oceanography and is remembered for initiating Scripps' deep-sea expeditions to the Pacific as well as for his role in promoting the International Indian Ocean Expedition. Although physical oceanography animated Revelle's vision of oceanography, he recognized and responded to increasing demands for fisheries science and ocean engineering projects. In 1951 Revelle created the Institute of Marine Resources (IMR), originally designed to house applied fisheries research separately from SIO. By the time IMR was established in 1954, its mandate had changed considerably to include plants and animals as well as minerals, beaches and bays, shipping routes over the sea's surface, and the ocean's capacity for waste disposal. Although Wilbert M. Chapman, a fisheries biologist whose activism promoted the tuna industry, had been considered as a leader for IMR, its first director was instead a naval architect, Admiral Charles D. Wheelock. Under him, IMR conducted such diverse activities as beach erosion studies, marine food chain investigations, city sewage projects, research on processing and storage of fish, ocean engineering, and even underwater archaeology.[11]

On-going studies of giant kelp beds conducted under IMR's auspices fostered the development at Scripps of scientific diving, another hard-to-categorize enterprise like IMR that was promptly placed there. In the late 1940s, graduate student Conrad Limbaugh began an industry-funded study of kelp beds, trying to determine whether harvesting of kelp reduced the numbers of fish, as sports fishermen accused. Continuing studies prompted by declines along the whole coast benefited from Limbaugh's early acquaintance with new diving technology. Limbaugh saw one of the first shipments of Cousteau-Gagnan Aqua-Lungs imported to the U.S. in a Westwood sporting goods store in 1949. After he persuaded his UCLA professor to purchase one for research, he teamed up with fellow GI Bill graduate student Andreas Reichnitzer to figure out how to use it. There were no instructions and no wetsuits, but the two avid skin divers enjoyed their experiences so much that they began to proselytize scientific diving. Fish known only as colorless preserved specimens had in life vivid colors and markings, and scuba offered scientists a chance to watch marine organisms in their natural environment. Limbaugh and Reichnitzer soon started training other scientists, initially people who were already divers or snorkelers. They taught procedures that they devised, including the buddy system and buddy breathing. In response to the deaths in 1952 of two University of California students using scuba, the University system mandated a formalized training program created by Limbaugh and other Scripps divers, which was then adopted by Los Angeles County when it originated the first formal public diving instruction and certification course. In parallel with this civilian, recreational development of diving, the diving group at Scripps was also involved in developing military applications of diving gear and techniques associated, for example, with preparing swimmers to enter waters soon after atomic bomb explosions.[12]

Popular interest in the ocean was fueled by scuba, which introduced thousands of people to the underwater world. Before scuba was widely available, Scripps scientists occasionally enlisted the help of a free diving club, the San Diego Bottom Scratchers, for various research projects. Founded in 1933, club members were more often recruited to assist with underwater photography, such as for the 1950 Jane Russell film *Underwater*. Most free divers and early scuba divers spent their time underwater spearfishing, although an increasing number turned to photography during the 1960s. To the consternation of many free divers, scuba opened the field to enormous numbers of people. By 1956 there were 132 dive clubs in California alone. Despite the spearhunting, not all divers were men. In 1953, Dr. Eugenie Clark published *Lady with a Spear*, which became a Book-of-the-Month Club selection. The ichthyologist Clark first started diving, using a hard helmet, while working as a research assistant for Dr. Carl Hubbs, the well-known Scripps ichthyologist.[13] One of the three people who created the Los Angeles County diving instruction course was lifeguard Bev Morgan. By the early 1960s, women could purchase specially designed ladies wetsuits. They were perhaps drawn to the sport by Zale Parry, who became the first woman to dive below 200 feet in 1954 and wound up on the cover of *Sports Illustrated*. Parry was best known for her work on the popular weekly TV show *Sea Hunt*, which aired from 1958 to 1961. That and other movies and television shows, such as Walt Disney's 1954 remake of *20,000 Leagues Under* *the Sea*, Jacques Cousteau's *Le Monde du Silence* ("Silent World," 1956), and *Flipper* (1963) brought the underwater frontier firmly into popular culture. The establishment of Sea World of California transported live marine mammals ashore for enthusiastic audiences.[14]

Undersea adventure was not limited to fantasy and the silver screen. In the early 1960s, explorers pursued depth records for human divers. Some sought sheer vertical penetration into the sea while others installed seafloor habitats with the idea that someday divers could live and work underwater. The activities of Jacques Cousteau, inventor of the Aqualung, were well-known, but both French and American entrepreneurs and militaries tackled this new frontier. Within the same week in 1962 that Cousteau established Continental Shelf Station Number One (Conshelf 1) in 33 feet on the French Mediterranean continental shelf, the American entrepreneur Edwin Link aided Belgian diver Robert Stenuit to spend 26 hours at 200 feet, in the Bay of Villefranche, using as his base a small aluminum recompression chamber. The two-person Conshelf 1 team, whose experiment was funded by oil companies interested in undersea drilling technologies, demonstrated that people could live underwater for the extended period of one week. The following year Cousteau and his five-person team inhabited a starfish-shaped habitat, Conshelf 2, for an entire month at 36 feet in the Red Sea and a small outpost habitat (which held two divers) at 96 feet for a week. The U.S. Navy's Sealab I was installed at 192 feet near Bermuda in the summer of 1964 and inhabited by four men for eleven days. Sealab was the in situ extension of the earlier Navy Genesis program, which from 1957 conducted a series of tests to extend human existence below the sea in depth and duration. The ongoing Sealab program would feature in Scripps' plans for the Island facility.[15]

The reason divers wanted to stay undersea related to one of the principal impediments to deep diving, namely the need for long decompression times following relatively short dives. Without decompression, divers—and also tunnel construction workers—suffered from the "bends," a painful and sometimes fatal disease caused by the inability of the body to eliminate excess gases absorbed from the atmosphere at depth. But decompression time did not increase with longer bottom time once the body had become saturated by these gases. The idea behind experiments with "saturation" diving, then, was to determine whether it was safe to keep divers at depth for long periods of time. If so, work at depth would be more efficient, because divers could rest, eat, and sleep at depth between work shifts, then endure only one long decompression.

Some experimental programs, such as the Navy's, probed the limits of human existence undersea, but once the safety of underwater habitats was demonstrated, many were installed at shallower depths in the mid 1960s. Habitats were constructed by university engineering students and local diving clubs as well as by governments and private industrial concerns. In the 1960s and 1970s, over sixty-five undersea habitats, constructed in seventeen countries, housed over 800 aquanauts who remained submerged for durations ranging from 24 hours to 60 days and at depths ranging from 5 to 300 meters. Activities conducted from them ranged from recreation to dam repair to oil well construction to science.[16]

Plans for the Scripps Island facility took shape in the context of the ambitious expectations for the oceans and their use that developed in the 1960s, in conjunction with the ambitions that Scripps researchers harbored for leading oceanography into the future.

EXPERIMENTAL MARINE BIOLOGY MEETS "MAN-IN-THE-SEA" RESEARCH

Active pursuit of an island facility at Scripps dated from the mid 1960s, but scientists within the institution first discussed the idea a decade earlier. At that point, the proposal was to construct a breakwater or rock mound island at the end of a short extension to the existing pier on the beach adjacent to the Scripps campus. Its main purpose would be to serve as a harbor for small boats, to make it easier for researchers to go to sea. There are several reasons why such a plan made sense at Scripps at the time. First, marine biology appeared to be on the brink of transforming from an observational to an experimental science. In 1956 Scripps and ONR co-hosted a symposium to discuss the future direction of this expanding field. A large Rockefeller grant had recently made possible an expansion of biological research at the University of California, San Diego, campus. Symposium participants, who were both marine and non-marine biologists, discussed areas that might profitably be attacked using experimental methods, naming physiology and evolutionary studies in particular.[17] Second, oceanic resources were on the minds of marine scientists because of the first United Nations Law of the Sea Conference in 1958, held in an attempt to negotiate the partitioning of the oceans and their resources.[18] At Scripps, concern about resource exploitation was channeled through IMR, which got involved at the end of the decade in serious discussions about preliminary designs for an island facility. Wheelock convened a group in 1959 that considered a breakwater structure and compiled information about the shape and size necessary given wave conditions in the area.[19]

There the matter stood until July 1964, when Revelle created a committee to convert ten years' occasional discussion into action.[20] The immediate spark came from two biologists who advocated an experimental approach to marine research, Per F. (Pete) Scholander and John D.H. Strickland. Strickland had arrived at Scripps only one year earlier to start a research group within IMR on food chain studies. Scholander, a physiologist who had been at Scripps since 1958, had recently assumed the directorship of the newly formed Physiological Research Laboratory (PRL), whose building, pool facilities, and ship *Alpha Helix* were funded by the National Science Foundation. This NSF support represented an institutional commitment to biological oceanography as a "critical area" in need of development. NSF was, at this time, making a concerted effort to fund "big biology," that is, major projects that bridged sub-fields within the imperfectly integrated discipline of biology and created national research facilities, in frank imitation of funding patterns in the physical sciences. Between 1957 and 1968, NSF spent $19 million on marine facilities, including laboratories and ships such as *Alpha Helix*, as well as the International Indian Ocean Expedition.[21] PRL was intended to form a bridge between physiologists at Scripps and colleagues at UCSD in biology and the new medical school. Their common ground would be vertebrate physiology underwater. The *Alpha Helix*, whose operating costs were covered for seven years by the National Institutes of Health, was designed to provide laboratory facilities for physiological researchers that could travel to animals that were difficult or impossible to keep alive ashore.[22] Indeed, Scholander and Strickland touted the prospective island facility because it would allow biologists to keep organisms alive in floating cages and also because of its potential to "foster a sea-mindedness" among staff members who, as the two complained, went years without getting in a boat.[23] (See Figure 1.)

While the promotion of experimental marine biology motivated advocates of the artificial island, the facility would also, Scholander and Strickland believed, put Scripps into the forefront of national "Man in the Sea" research, as they called it. This term also referred to U.S. Navy saturation diving programs as well as nascent civilian research in universities and the industrial sector (and was often later hyphenated as "Man-in-the-Sea"). At PRL's founding, one of its main projects was defined as, "cardiovascular and

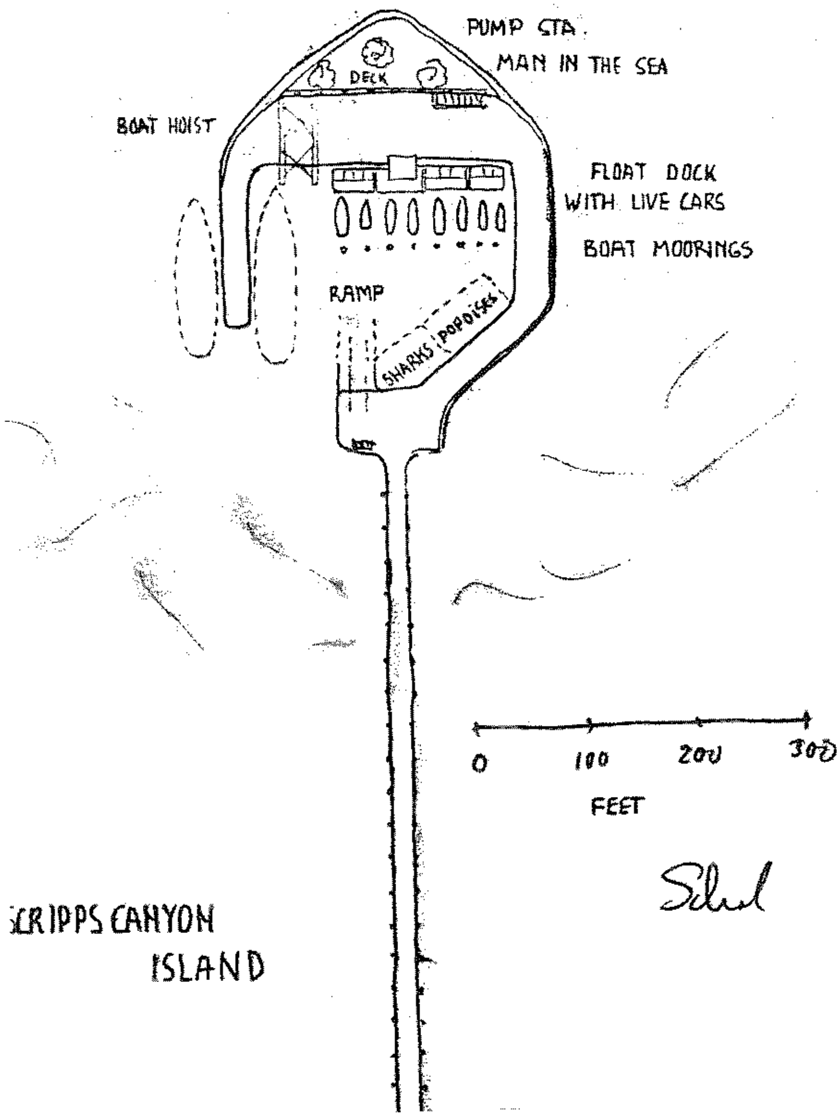

FIGURE 1. Drawing by the Scripps Island committee in June 1964, illustrating the range of uses intended for the facility, including: docking of large research vessels and submersibles, seawater intake system, and man-in-the-sea research. Faculty members hoped the island would promote physiological research and encourage Scripps staff members to spend more time at sea. (SIO, AC 6, Box 10, f. 65.) *Drawing used with the kind permission of Scripps Institution of Oceanography, University of California, San Diego.*

respiratory research on large marine vertebrates and 'aquatic' man."[24] A month before Scholander and Strickland asked Revelle to take action on the island idea, Scholander received a letter from a colleague calling for a national underwater institute, preferably associated with a medical school. Hermann Rahn, a physiologist at the State University of New York at Buffalo, argued that the time had come to shift research in this area to a civilian setting. He cited the potential food and mineral resources of the continental shelf as a motive, asserting that Navy research was "unlikely to be able to satisfy the needs of industry." He also criticized isolated research organizations such as characterized industrial space medicine, counseling instead a centralized approach to investigation of physiological and medical problems of human exposure to high pressure. Scholander and Strickland urged Revelle that Scripps would be an ideal location for a national institution for Man-in-the-Sea such as Rahn proposed, and Revelle agreed to invite Rahn to campus to discuss the issue in conjunction with consideration of a breakwater island.[25]

The island concept appealed to many of the Scripps faculty. The original idea of a small boat shelter held the attraction of enabling work at sea most of the year, in most weather. Such a facility "would supply the faculty with enticement to spend time on the sea for creative inspiration as well as some leisure."[26] In addition, new facilities such as the tanks of PRL created a need for a large pumping station for clean seawater that could be fulfilled by an island connected to shore with a pier. At this point, sketches of the facility placed the island on the rim of the precipitous Scripps Canyon, about twice as far seaward as the end of the existing pier. Easy access to deep water became the critical feature of the proposed facility, one that resonated with mounting enthusiasm for imaginative uses of the sea. Within days after Scholander and Strickland's memo to Revelle, but before he formed the committee, the physical oceanographer Walter Munk alerted Scholander to "the almost unique possibility" of building an underwater "walk" from the island into the canyon, with a series of shelters at various depths up to 500 feet.[27]

Although imaginative, Munk's suggestion seemed well within the bounds of possibility at the time. Cousteau's Conshelf 2 installation had already demonstrated the use of one habitat as a base for a deeper one as well as the use of an underwater hangar installed adjacent to Starfish House for his diving saucer. In 1963, the inventor R. Buckminster Fuller filed a patent for an undersea island that could be used to dock ships at the sea's surface and submarines beneath.[28] In the same month that the Scripps Island committee convened, The Oceanic Institute in Hawaii tested a pilot underwater structure at a depth of 30 feet off Manana Island with the intention of constructing a permanent undersea laboratory that would serve as a "base camp" for stepwise explorations of adjacent depths by divers, small submersibles, trained marine animals, and remotely-controlled, instrumented torpedoes. The Hawaiian facility was planned in conjunction with the popular attraction, Sea Life Park, as well as the "advanced scientific and industrial community" in Honolulu. Planners conceived a chain of permanent underwater laboratories constructed as part of a multi-million dollar undersea research program, Project Makai. An artist's conception of a similar facility depicts a laboratory see-through dome adjacent to a museum-restaurant dome providing public access to a marine park on the ocean floor, complete with an electric railroad tunnel tour.[29]

Between July and October of 1964, Scripps faculty articulated the features they envisioned for what they began to call Scripps Island. Its harbor should have berthing space for between five and ten skiffs, plus two 45-foot vessels, as well as a diving saucer and a larger submersible. It should also permit the docking of 150- to 200-foot ships "frequently." At this point, Scripps was leasing a Westinghouse diving saucer that researchers used extensively for local dives. For example, geologist Francis Shephard used it to continue his exhaustive study and mapping of the Scripps submarine canyon, while ecologist Edward Fager employed it to extend on-going investigations of benthic community structure. In the mid 1960s Scripps also had two large vessels, *Argo* (213′) and *Alexander Agassiz* (180′), with two more 200+ foot vessels on the drawing board or near conception. In addition, the imaginative 355-foot *Floating Instrument Platform*, or *FLIP*, had been in operation since 1962. FLIP rotated from the horizontal to the vertical position in order to gain access to the relatively calm water beneath the surface wave zone.[30] Besides serving as a way station for the varied and growing Scripps fleet, the Island should include facilities for holding live animals: small tanks connected to a floating dock in the harbor, as well as two large (20 foot square) mesh cages attached to the bottom. Seawater pump intake lines should supply water to campus from several depths and sensor cables should be run from shore to the island for purposes to be determined in the future (such as recording temperature, waves, currents, light penetration). Diving facilities would be a main feature of the Island, whose underwater section would include a wet well to the bottom with openings at 30, 45, and 60 feet. From the well's floor, tracks should lead down the canyon "to a considerable depth." A parallel dry well would provide viewing ports and observation stages at ten-foot intervals. The island's features would position it "to serve as a basic stepping stone" for developing all areas of physical and biological underwater research. Not only would it support "present means of exploration," but it would also foster the future of undersea exploration and promote "the ability of man to do science underwater."[31]

Members of the Island planning committee were proud that Scripps had pioneered the application of scuba to basic science, which explains the emphasis on diving. They understood that this facility, although promoting existing strengths of the institution, would also nudge Scripps in a new direction, towards a greater involvement with Man-in-the-Sea research. Indeed, as discussions proceeded about the features of Scripps Island, faculty not only had use of a diving saucer, but they also played a central role in Sealab II. Douglas Inman later asserted that Scripps' involvement with these two projects was "highly motivated, at least in part, by the desire to obtain environmental and background information applicable to the Scripps Island facility."[32] While Sealab I took place off the Bahamas, the Navy chose to situate Sealab II near La Jolla to take advantage of the combination of deep water near shore and support facilities at Scripps. The experiment lasted for 45 days between August and October of 1965, involving three teams of ten aquanauts living in and working from the specially-designed and built, canister-shaped habitat. One major contribution, from the Marine Physical Laboratory, was an underwater electronics laboratory built by Victor C. Anderson to provide communications to shore. Two Scripps divers and three graduate students numbered among the teams of aquanauts, who also included the former astronaut Scott Carpenter. Partly because of Carpenter's participation, Sealab II became a major media event that drew attention to undersea research and also to Scripps Institution.[33] During the thirty days that Carpenter spent living at 205 feet, he spoke by radio with astronaut Gordon Cooper in Gemini 5, circling 100 miles above earth. He also spoke with President Johnson, who probably did not understand much of Carpenter's helium-influenced speech. Sealab aquanauts also spoke with Cousteau's Conshelf 3 team, working at exactly the same time from Starfish House, which had been installed in the Mediterranean Sea off Cap Ferrat. Scripps continued to be involved in underwater habitat programs after Sealab II. In 1969 Sealab III, a reconfiguration of the Sealab II habitat, was placed nearby, off San Clemente Island, although the project was scrapped when one of the aquanauts died while trying to get the habitat ready for occupation. Just one year later, two Scripps graduate students attracted enormous media attention for their participation in the first all-woman aquanaut crew of the undersea habitat Tektite II, located in warmer, more hospitable waters of Great Lameshur Bay, St John Island, in the Virgin Islands National Park. In short, Scripps displayed considerable interest in undersea exploration and, at the time its faculty planned the Island facility, at least some of them saw the institution's future tied to "in-water science."[34]

NEW SYNTHESIS DREAMED FOR OCEAN SCIENCES

In this era of generous funding for ocean science, Revelle began to pursue support for the Island almost as soon as he formed the committee. To the meeting with Rahn about the need for a national "Man in the Sea" program he invited representatives from NSF and NIH, although the latter could not attend.[35] Within weeks after the committee's first meeting, Revelle penned a lengthy letter to Arthur E. Maxwell, head of the geophysics branch of the Office of Naval Research (ONR) and sent copies to Harve Carlson, director of NSF's division of biological and medical sciences; Richard G. Bader, NSF's program director for oceanography; Howard Eckles, Assistant to the President's Science Advisor; Richard D. Vetter, of the National Academy of Sciences; and Captain C.B. Momsen, of ONR. Revelle described the facility, enumerated the broad range of basic and applied research it would support, and asked whether "we are simply having a pipe dream or whether the idea has merit and feasibility."[36]

Responses were enthusiastic, from these and other commentators. "Terribly exciting," wrote a Duke University zoologist, with "a great deal of merit from the scientific viewpoint," commented Carlson. What most observers appreciated was the prospect not only of developing existing and new areas of ocean sciences but of tying these together coherently. Eckles praised the opportunities for research in fish behavior, plankton distribution and behavior, sedimentation processes, and water circulation, and also noted the potential for instrument development and improvement of techniques. Maxwell liked the idea because "it ties together a number of facets of oceanography which seem to be wandering in no particular direction, yet all seem to be important enough to warrant further attention." Furthermore, he added, "It seems to me that the kind of dreaming and thinking that goes along with this kind of endeavor is something that has been missing from the oceanographic effort in the past few years." He indicated that Navy funding was likely and felt there was a good possibility of attracting non-navy support as well. Only Eckles suggested that funds would likely not be forth-

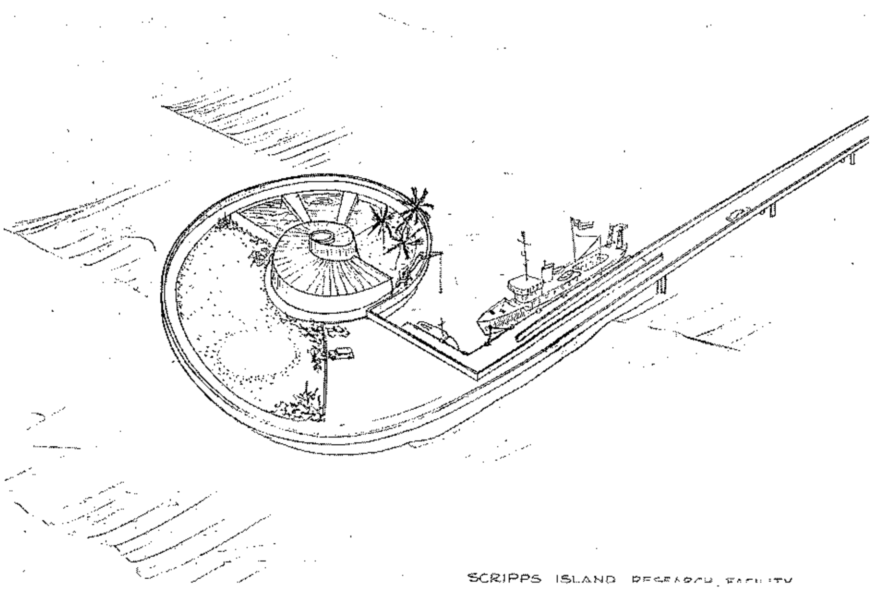

FIGURE 2. Drawing from an October 1964 proposal by Willard Bascom's firm, Ocean Science & Engineering, Inc., which argued for the importance of considering aesthetics as well as function and cost in the Scripps Island design. (SIO, AC 6, Box 10, f. 66B.) *Drawing used with the kind permission of Anitra Bascom Wirtz.*

coming from his quarter, the Department of the Interior. Others offered advice about other experts Revelle might contact and asked to be kept informed about the project. Maxwell inserted one note of concern due to Revelle's impending retirement, that "it may falter without the dynamic interest of a person such as yourself behind it."[37]

Before Revelle handed the institution's reins to physicist William A. Nierenberg in July 1965, substantial background work had been completed in preparation for the Island facility. A wave recorder was installed in October 1964 to provide at least a year of continuous readings.[38] Preparations for Sealab had resulted in data sufficient for the creation of charts of the Island site and the rims of both adjacent canyons.[39] Detailed specifications were determined by staff scientists from all disciplines.[40] In addition to making inquiries of potential funders, Revelle also contacted an engineer with a close relationship to the Institution for assistance with a ballpark cost estimate. Just two weeks after he formed the Island committee, Revelle telephoned Lief J. (Jack) Sverdrup, the half brother of former Scripps director and world-renowned oceanographer Harald Sverdrup. As one of the partners of a St. Louis engineering firm that built the artificial islands for the five-mile-long Chesapeake Bay Bridge in Maryland, Sverdrup proved a valuable resource for Scripps. He offered to visit within the month and soon after returned results of a preliminary study that indicated a four million dollar price tag for the project.[41] This estimate was considerably higher than the 1 to 1.5 million first suggested for a rubble mound structure, but less than the bottom line suggested by Willard Bascom's engineering firm.[42]

Bascom, an engineer employed by the National Academy of Sciences to advise on technical aspects of deep sea drilling had been responsible for many of the technical successes of the early Mohole project. In 1962 he formed Ocean Science and Engineering, Inc., and tried to parlay his experience with the ambitious program to drill through the earth's crust to the mantle into jobs for his company. In October 1964, Bascom's firm submitted an unsolicited proposal for a complete design study for Scripps Island that estimated a cost of five to six million dollars. This proposal employed an analogy that became a rallying cry for the facility: the cost of construction would be comparable to a research vessel although the island would last ten times longer.[43] Bascom's firm also emphasized an issue that had earlier been raised very briefly, namely the importance of aesthetic considerations in the island's design. Back in 1960 when Inman discussed the breakwater idea with IMR's director Wheelock, he admitted that although "it would be desirable to come up with a more elegant type of structure," a rubble mound would be the cheapest solution.[44] In 1964, drawings of Scripps Island revealed functional rather than aesthetic priorities. By contrast, Bascom urged that, because this would be the first facility of its kind, imagination and beauty should receive high priority. It should not, he warned, be a concrete-covered pile of rubble, nor a biological work yard like the rear of the aquarium building or a storage area for boats like the Scripps pier. To receive support, it must, he believed, be designed "with attention to beauty as well as function and cost." To his end, his firm proposed a nautilus-shaped island topped with grass and palm trees, attractive from shore, with its working facilities hidden underneath the park-like top layer. A side profile captures fully the enthusiasm for underwater research, with a series of underwater houses adjacent to wet and dry shafts, the former of which served as a diver training tank with ports to the outside at various depths.[45] (See Figures 2 and

3.) Bascom's design, while more imaginative than pictures drawn by Scripps researchers, incorporated elements already described in specifications drawn up by the ad hoc committee.

OCEAN ENGINEERING AS A MOTIVE

At the time that Nierenberg took over the helm of Scripps from Revelle, committee members and the new director agreed that the time had come to move forward with necessary engineering studies. Scripps had some essential expertise in house for investigating effects of waves on the proposed structure and effects of the structure on the beach. Inman, for instance, was an expert on nearshore processes. The Hydraulics Laboratory, completed in 1964, had tanks that could be used for model testing. It was clear, though, that for a project of this magnitude, Scripps would need outside assistance.

Nierenberg first turned to the Ford Foundation, in February 1966, to request financial assistance to cover either the engineering study or, if possible, the entire project. After a meeting at Scripps with Foundation representatives the following winter, Nierenberg received the disappointing news that a formal proposal was not recommended.[46] He had meanwhile approached Lockheed Aircraft Corporation in June 1966 for a contribution to cover an engineering study for the facility, assuring the company that he expected the federal government to fund construction, probably through ONR. He stressed the applications of the technology that would be developed for rescue and salvage, undersea mining, oil field drilling and well completion, and sea farming. Although all companies with commercial submersible vehicles, including the Electric Boat Company, General Dynamics, and Westinghouse, as well as Lockheed, stood to profit from this development, Lockheed's closer proximity to Scripps than these others suggested the partnership that Nierenberg proposed. Unfortunately, Lockheed, too, declined involvement in the enterprise.[47]

Nierenberg had better luck with local industry. In June of 1966, Walter Munk sounded out Mr. Robert O. Peterson, president of the Foundation for Ocean Research (FOR), regarding the likely reception for a proposal from Scripps for a detailed design study for an Offshore Research Facility.[48] FOR was a non-profit San Diego institution with close ties to Scripps. Indeed, its members in October 1968 consisted of Peterson and Richard Silberman, who together founded and owned Foodmaker, Inc., parent corporation of Jack in the Box restaurants, plus three Scripps faculty: Nierenberg, John

Isaacs, and Walter Munk.[49] In May 1967, Peterson invited Nierenberg for lunch with Dick Silberman to discuss the Scripps Island proposal. That meeting resulted in an agreement that Peterson and Silberman, though FOR, would attempt to raise the $75,000 needed for an engineering design study for this project, which would, in Nierenberg's words "be the next logical step in our history of always being first in oceanographic research."[50] Within two weeks Peterson had secured a promise of $25,000 from General Dynamics-Astronautics, which he used to try to raise similar amounts from two additional firms. He wrote to Ryan Aeronautical Company in San Diego and Rohr Corporation in Chula Vista, claiming to be acting "only as a catalyst" in this effort to "bridg[e] the gap between Scripps and the business community." He noted that General Dynamics had already benefited from the liaison by embarking on a joint project on deep sea buoys with Scripps.[51]

In a thank you letter to Peterson, Nierenberg stressed a new characteristic of the facility that became a central argument in Scripps' justifications for its construction. As more fields developed in oceanography, Nierenberg explained, citing medicine and ecology as examples, it became more important to help researchers surmount the air-sea barrier, freeing them to "reserve maximum effort for engineering or science work."[52] Within medicine, he meant hyperbaric studies and human underwater physiology, fields integral to saturation diving and underwater habitation experiments. To Edward Wenk, Jr., the executive secretary of the interagency National Council on Marine Resources and Engineering Development, Nierenberg noted that one major problem in expanding ocean sciences was that of recruiting talented people from non-oceanographic disciplines to work on problems involving the sea. "Attraction of working in the ocean is so romantically very great until individuals get seasick or battered around by the surf and waves or nearly get crushed between a flying piece of equipment and a bulkhead." To get doctors, physiologists, academic ecologists, and engineers involved in ocean research would require systems of tubes and railways that minimized contact with the sea—in short, the kind of access offered by the Scripps Island facility.[53]

Under Nierenberg, ocean engineering became a major component of the Scripps Island plans, alongside "Man-in-the-Sea" research and branches of biological, chemical, and physical oceanography. Nierenberg emphasized the technology development aspect of the Scripps proposal in his letter to Wenk, written on the same day that Peterson wrote to Ryan and Rohr. He contacted Wenk after a State Department meeting of scientists held to discuss international marine science and engineering. During a discussion of

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The time seemed auspicious for a novel, large-scale undertaking in the area of marine science and technology. The NSF was engaged in a proactive effort to develop "big biology," having identified biological oceanography as a critical area for development. The midpoint was approaching of the decade earmarked by NAS for the promotion of oceanography. A small but vibrant industrial sector for creating innovative undersea exploration technology, of which Bascom's firm was an example, was emerging. On the national political scene, the year 1966 marked the passage of the Marine Resources and Engineering Development Act, which set forth objectives for a national ocean program. Wenk described this legislation as the "the single most important event in enlisting the seas to the service of man."[55] In December 1967, Scripps confidently submitted a proposal to the Panel of Marine Engineering and Technology of the Commission on Marine Science, Engineering, and Resources.[56] No reply from Wenk or response to this proposal appears among papers relating to the island facility, however, and federal funding was not forthcoming for the study.

In the end, local funding carried the project forward. In fall 1967, once FOR had raised half of the $75,000 it sought, Silberman made a "sudden proposal" to approach the City of San Diego and ask for a matching contribution of $37,500.[57] Because both sides wanted to take action before Election Day, action was swift. By October 20th, the deputy mayor had indicated to the mayor and councilmen his opinion that it was not only desirable to support a research center that would attract scientists and, more importantly, companies to San Diego, but it was important that the study be conducted under the City's auspices. Federal funding would produce a general design for any coast, while local sponsorship would ensure that "the resulting proposal will be tailor made for San Diego."[58] By January of 1968, a draft agreement between FOR and the city was ready for approval.[59]

Some public discussion of the project ensued, but acceptance of the idea by the community was relatively easy to achieve. The city council considered the possibility that the island facility might set a precedent for the construction of commercial offshore structures, but easily dismissed this concern with the agreement that a "strictly scientific institutional facility" would not open the door for unwanted development.[60] Late in 1967 Fred Spiess, then chair of the island committee, made a presentation to the La Jolla Shores Protective Association about the proposed facility, then met in early January with its board of directors for a follow-up discussion. Other than insisting that the design take aesthetics into consideration, the group raised no objections. After Spiess left the meeting, the association recorded in their minutes support of the venture, even offering to make a public announcement of their support in the future, as long as no substantial changes were made to the proposal.[61] In advance of final approval for the funds in February 1968, citizens at the La Jolla Town Council meeting voiced concerns about beach erosion and placement of a solid rockpile causeway. Rather than endanger the appropriation, these concerns merely prompted the Council to recommend that Scripps adopt the term "pier" instead of "causeway" to imply a structure with an open base.[62] By fall of 1967, then, the Island project, having embraced the burgeoning field of ocean engineering, seemed poised for action.

AESTHETICS AND EXEMPLARY ENGINEERING

When it became clear that San Diego would likely match FOR's contribution for the preliminary engineering study, Scripps hired a project engineer to develop a practical engineering design for the facility. Robert Oversmith was an ocean engineering consultant who had worked for General Dynamics before taking on the presidency of Ocean Dynamics. Most relevant to the Scripps project, he had worked on a glide submarine and undersea oil storage rigs. Scuba diving numbered among his hobbies. In Oversmith's first few weeks, he suggested to Spiess a new approach to the structure of the facility which, if built, would represent a significant ocean engineering feat. Instead of an island that extended to the sea bottom, he proposed a hull structure supported by four large legs anchored to the bottom. Such a platform could be built ashore and towed to the desired location, possibly resulting in lower construction costs than for a monumental structure built at sea. An open

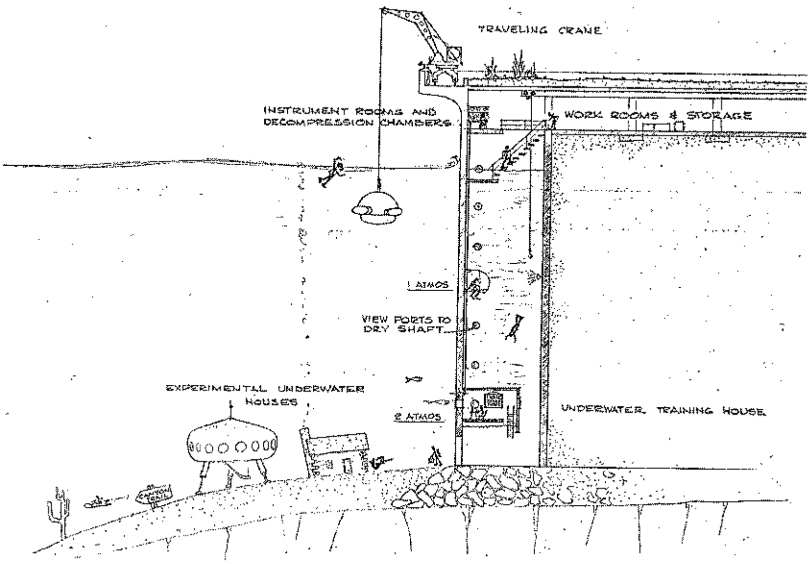

FIGURE 3. Side profile by Bascom's firm, which incorporated elements specified by the Scripps Island committee, captures the enthusiasm of the time for underwater exploration, particularly the emphasis on man-in-the-sea research. (SIO, AC 6, Box 10, f. 66B.) *Drawing used with the kind permission of Anitra Bascom Wirtz.*

structure would not block water currents and sand transport, a feature that would help address local concerns that the facility not affect the popular La Jolla beach. More importantly, the open base would permit the utilization of the area under the island for tubes, habitats, cages, submarines, railways, tramways, equipment, and other accouterments of scientific research or "man-in-sea" well into the future.[63] (See Figure 4.)

The committee liked the hull-on-legs design for many reasons, including the technological innovation it represented. Spiess praised the idea for "the novelty of the approach and the generalizations which might be possible." By contrast, Spiess and Oversmith objected to the true island plan because it offered "no advancement in design technology." Although Scripps Island was intended as an oceanographic research facility, Oversmith saw prospective applications to oil drilling, mining, and fishing, as well as to recreational activities including marinas and resorts.[64] In December 1968, Oversmith summarized the specifications for the island and enumerated three design constraints, all met by the hull-on-legs design. The island must have no significant effect on adjacent beaches, minimal effect on the sea floor, and "aesthetic values in keeping with the coastline, the community, and the university."[65] Below the surface, though, nothing constrained the imagination of Oversmith and the committee. While the original harbor idea was preserved, the structure itself would now provide a work platform at sea level, laboratories above water and under sea level, holding tanks, observation windows and tubes, seawater intakes at multiple levels, and entrances for divers, cables, and equipment. The legs would be functional, each designed for a specific research activity. One would support in situ research, another "man-in-sea" work, the third biological research, and the fourth equipment research and development activities. The latter indicates the growing importance of ocean engineering to the vision of Scripps Island, as does, perhaps, the very comprehensive list of suggested methods for access to the facility, including tunneling, monorail, aerial tramway, underwater railway, helicopter, and "ICBM" (the latter presumably a joke).[66]

With the in-house specifications and preliminary designs complete, the next step involved sending requests for proposals to qualified engineering firms, many of which had already been corresponding with Oversmith or other members of the committee to offer their services. With little comment, the revised specifications for the hull-on-legs design included a raised cost ceiling of $10 million. This sum represented a departure from the idea that the facility could be built for approximately the same amount as a research vessel. Rather than cost, committee members seemed swept away by the conviction that "it is important that Scripps Island be a real step forward in terms of oceanographic-engineering structures, and that it be aesthetically pleasing."[67] Discussion of the idea of asking an architect to aid with basic form for the design went nowhere, however, probably for financial reasons. As replies came in from companies indicating that they would submit a proposal, Silberman inserted a cautionary note that the outside company chosen should provide engineering and cost estimates for the Scripps design, not invent its own design. Furthermore, FOR trustees, four of six of whom were Scripps faculty members, decided to apply for patents for the basic designs developed in-house, anticipating future use by scientific, industrial, and government sectors.[68]

Of the twenty-four companies invited to submit proposals, fifteen did so. Companies tended to have experience constructing port facilities or offshore drilling platforms. John A. Blume & Associates, for example, had built an offshore drilling platform in the Persian Gulf and a deep water tanker terminal off Saudi Arabia's coast. Other companies included J.H. Pomeroy, Kaiser Engineers, Koebig & Koebig, Inc., Ferver-Dorland & Associates, and Sverdrup and Parcel. Some companies were rejected because they mostly did construction, not design, while others had insufficient experience in ocean work. Oversmith worried about this with respect to the point person at Sverdrup and Parcel, but it won the contract anyway due to, as Oversmith recorded later, its "posture in Washington."[69] Certainly the Sverdrup family connection and Jack Sverdrup's early involvement in the project could not have hurt.

Engineers at Sverdrup and Parcel began work in summer 1968, while the Scripps committee took steps to ensure that the island would not be excluded from the canyon rim by a California committee that was meeting to decide on the location and restrictions for three proposed underwater parks. Fortunately, long-time Scripps diving officer Jim Stewart was a member of the state committee.[70] After a meeting at Scripps in early August, the Sverdrup and Parcel project manager, William Wundrack, noted that the island committee stressed the need for an aesthetically pleasing structure. "At the moment," he recorded, "they are more concerned with obtaining an attractive structure and a structure that will harmonize and blend into the surrounding area. The economics of structure are somewhat secondary at this time." By late summer, when Sverdrup and Parcel submitted several preliminary designs, Scripps committee members were taken aback by the tentative price tag of $17.4 million. Starfish and silo-shaped designs also prompted complaints that the company had departed too drastically from the in-house design. As was often the case at Scripps, certain of the scientists' wives got involved in the discussions. Mrs. Spiess felt that a teepee shape design was too hard and would be difficult to sell to the community, while Judith Munk, herself an architect, condemned that same design for having no feeling of the sea.[71] Sverdrup and Parcel returned to the drawing board and submitted a few more ideas for basic shapes, but continued to insist that the structure would cost $15 to $17 million. Faced with this new order of magnitude estimate, Scripps faculty and FOR trustees chose the "first class" route and instructed Sverdrup and Parcel to stay below $18 million including all contingencies and inflation.[72]

Soon after making this decision, some committee members regretted it. In mid October Spiess viewed the latest plans from Sverdrup and Parcel and confided his misgivings to his director and also to the president of FOR.

"This triggered in my mind a review of how we made the decision to relax our earlier 10 million dollar limit." He noted that the current design increased the size of the legs and hull substantially and he reminded Nierenberg and Peterson that the facility was intended to support research and education as well as to provide leadership for the oceanographic community by building a prototype structure. "This does not mean building a monument to Scripps Institution," he objected. He also resurrected the comparison to a research vessel and insisted that the time had come to put "things somewhat in proper perspective."[73] Oversmith, too, worried about the high cost, fearing that it would reduce the likelihood that the facility would be constructed. Oversmith assured the committee that the prospects for cutting the cost to $10 million were excellent, but he also reminded members that the island "incorporates many new developments each of which is new and important individually, into one outstanding facility."[74] It would be difficult to turn back from such advances in ocean engineering.

Despite complaints and fears, Sverdrup and Parcel demonstrated the feasibility of the hull-on-legs design, and judged it the optimum arrangement for the diverse uses intended for the island. The company emphasized that the design was functionally related to the facility's purpose, yet showed "considerable esthetic sensitivity for the feelings of the land-based viewer." It touted the design as "extremely flexible," with the potential to serve the broad range of possible directions for future oceanographic research and the technology that would be required to prosecute it. In addition to the marine biological, oceanographical, physiological, and medical research that had all along been touted as beneficiaries of the island, the Sverdrup and Parcel design study followed Oversmith's lead and emphasized the ocean engineering aspects. Engineering advances would not only support science, but would also directly promote industries such as rescue and salvage, undersea mining, oil drilling and extraction, and sea farming. Clippings collected by Scripps personnel suggest that, at the time, artificial islands were conceived to address a wide variety of problems, from the need to expand the Los Angeles airport to the space constraints of Belgian harbors. Given the strong emphasis on man-in-the-sea aspects of the facility, it is interesting to note that the study predicted that the engineering program would "develop tools and remote handling equipment for operational use." In sum, the design study described the facility as a solution to the problem: "how does man live closely with the sea, and enter it easily at will."[75] As we shall see, however, ocean scientists were no longer articulating the problem in these terms.

Even before Sverdrup and Parcel presented the final concept design, committee members had judged it a wrong turn. Although it represented a "very useful exercise, well worth the money," the design must be used as a starting point for Oversmith to step down the facility to a more reasonable scale.[76] Meanwhile, Scripps was having to hold the media at bay. When the requests for proposals went out in March 1968, the chair of the Island committee had to fend off a photographer from *Time* and *Life* who wanted to feature the Scripps Island model. An effort to prevent local news media from descending on campus a few days later apparently failed.[77] When the deadline for Sverdrup & Parcel's study neared, *Oceans* magazine tentatively scheduled a major article on Scripps Island for their April 1969 issue. It fell to Oversmith to plead for a delay of several months.[78] In spring of 1969, Nierenberg presented the Sverdrup & Parcel report to the City of San Diego and Scripps set in motion the process of acquiring from the city a lease for the undersea land on which the facility would be built.[79] Nierenberg insisted, however, on "three months of quiet internal arranging to plan fund campaign with caution and with no selling at all."[80] While Oversmith worked on a revision of the Sverdrup & Parcel design, Nierenberg tried to get the island facility on the list of projects for the University's five-year capital campaign.[81] Officers of UCSD chose not to approach the state for funds before construction costs had been secured, but they expected the state to cover replacements costs for the existing pier.[82]

NEW ENVIRONMENTAL CONCERNS

While Scripps insiders remained confident that they could raise funds from several federal agencies which together would permit construction of the facility, they began to recognize a new kind of impediment to their project. Overtures to the Department of the Interior made by FOR's new director, Dick Silberman, resulted in the discouraging news that an upcoming governmental reorganization would render Interior unable to contribute to the project. The Secretary of the Interior stressed, though, that the ability to launch equipment without interference from surface conditions would prove valuable to the oil industry and other oceanic commercial activities. He therefore proposed that Scripps approach the Secretary of Commerce, under whom the proposed National Oceanic and Atmospheric Administration (NOAA) would become a potential source of funds, along with NSF.[83]

However, within weeks after Scripps' first news release announcing approval by the University Regents to pursue the island seriously, John Isaacs, in his capacity as acting director, issued a terse order to Oversmith to "knock out anything comparing this with oil rigs."[84] The news release had touched off a storm of protests and inquiries from area residents, some associated with the University. A mathematics professor expressed his dismay to the chancellor, insisting that any attempt "to despoil this irreplaceable area with an unsightly offshore platform is beyond comprehension."[85]

Representatives of the state legislature, the local chapter of the Sierra Club, editorial writers in local newspapers, local citizens, and also people from as far away as Boston contacted Scripps to raise objections and ask hard questions. Critics doubted the wisdom of accepting reassurance from Scripps insiders that the design adequately addressed concerns about aesthetic and physical effects of the facility on the environment. A geophysicist who saw an announcement in a professional newsletter asserted that there was, for science, "no benefit worth the distortion of the natural aspect."[86] Others worried about the precedent for offshore construction. "Imagine a hotel in the kelp beds off La Jolla, a marina/resort just off Laguna Beach," moaned one particularly persistent and vociferous critic.[87] This, of course, had been exactly the vision embraced with enthusiasm just half a decade earlier by innumerable popular writers, engineers, and dreamers.

Scripps spokespeople were surprised and puzzled by the attacks. A number of scientists there were at the forefront of developing the field of environmental science. From the 1950s, Scripps investigators studied the effects of radioactivity in the oceans and investigated the greenhouse effect. The following decade, chemists explored the distribution of poisons such as lead from gasoline and chemicals from insecticides. Geologists studied transport of sand by waves, looking both at natural processes and those resulting from artificial structures.[88] Many of the Scripps Island proponents considered themselves uniquely qualified to judge the Island's impact—and its potential utility to this burgeoning area of marine science. In response to arguments against despoiling the ocean environment, Scripps Island defenders continued to stress the technological uniqueness of the facility and the solution it represented to "the problem of the surf zone." They pledged "minimum disruption" to the beach and undersea environment. Critics, however, condemned even that.[89]

Acknowledgment of the importance of community involvement and aesthetics, which had been emphasized throughout, was once more brought forward. The Island committee organized a community meeting early in 1972, in part to address the worries of area Sierra Club members but equally to demonstrate to concerned citizens the stalwart support of certain segments of the population. Nierenberg invited to the meeting representatives of the La Jolla Shores Association and the La Jolla Town Council, two groups that had strongly supported the Island project.[90] To this assembly, Nierenberg admitted that funding prospects were not good at present, but he insisted that the facility was "needed more than ever."[91] The same pressing environmental issues that provoked condemnation of the proposal from outsiders seemed to insiders to underline the need for such a facility. The prospects for major contributions to ecology, beach erosion, pollution, basic engineering, and medicine, which Nierenberg called "the problems of our times," brought the need for such a facility, he argued, into "sharper focus." Furthermore, the range of conflicting uses of the coastal area—exactly the point of contention with regard to the facility—suggested to Nierenberg the need for a facility that would provide research access to large numbers of scientists and engineers from a variety of fields.[92]

Although public opposition took the Island committee by surprise, no one had imagined the possibility of serious opposition to the project from within the institution. Oversmith finished his version of a conceptual design for the structure in December of 1971. In his report he asserted that "the project has come to be regarded as vital to the broadening of research and instruction at Scripps Institution and as a significant development in the field of marine science in general."[93] When the Island committee organized a survey of Scripps faculty and graduate students to determine "the opinions and interests of the Scripps Staff with regard to the Island," long-time proponents of the idea found themselves outnumbered.[94] Although a few enthusiasts insisted, "Most assuredly, SIO must lead in the development of this project," the majority of respondents to the questionnaire "did not feel that it is a first order priority." Some raised objections to "an engineering exercise" that would not contribute significantly to Scripps' scientific programs, although a few people thought that Scripps could use the facility to demonstrate "the practicability of such a research facility in the ocean without adverse effect." Only one person invoked "man-in-the-sea" research, a long-time member of the Physiological Research Laboratory who sat on the original Island committee in 1964. Most damning of all, very few researchers indicated that they would use the facility on a daily or weekly basis, while one-quarter of respondents could not imagine using it ever.[95] Two years after the survey, the then-chairman of the almost forgotten Island commit-

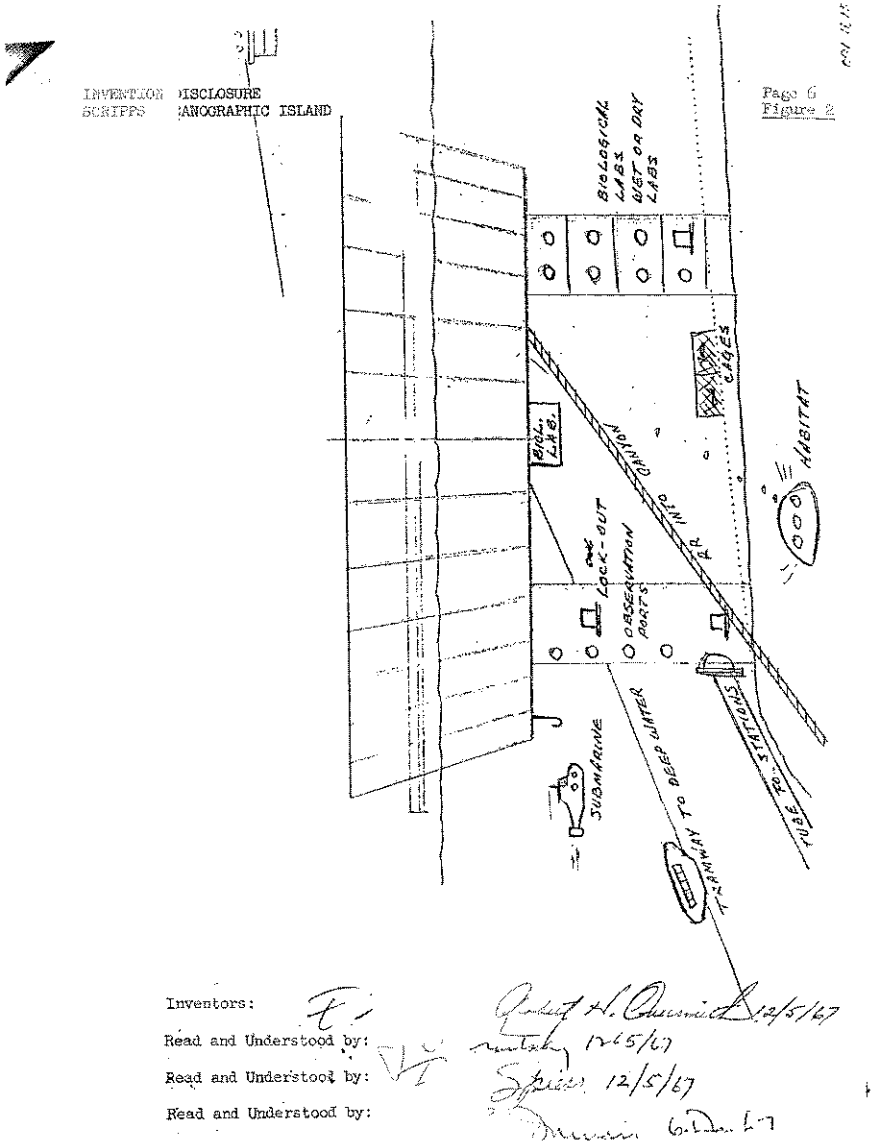

FIGURE 4. Side profile of hull-on-legs design created in 1967 after Scripps hired project engineer Robert Oversmith. The new specifications confirm the central place of man-in-the-sea research while emphasizing the facility as a contribution to ocean engineering. (SIO, AC 2, Box 92, f. 92/6.) *Drawing used with the kind permission of Scripps Institution of Oceanography, University of California, San Diego.*

tee, Victor Anderson, wrote a final report and recommended the committee's disbandment.[96]

ROAD NOT TRAVELED

NOAA did go on to develop a Man-in-the-Sea project to provide civilian researchers with access to underwater laboratories. Although by 1984 only one American habitat remained in use, many new ones were constructed in the early 1970s, at exactly the same time that Scripps researchers lost interest in the Island facility. Some of the reasons for the failure of Scripps Island to materialize relate to the overall demise of undersea exploration by humans, but others are rooted in the development of ocean science and technology and its relationship to the marine environment.

Ultimately, underwater exploration by humans gave way to remote sensing technology. This was due in response to the danger of diving, as in the abrupt termination of Sealab III after a diver died trying to install the habitat. Computerization and miniaturization of technology began to offer viable alternatives to data collection by people. Most importantly, industries and scientists stopped insisting on the necessity for direct human observation and manipulation of undersea equipment, emphasizing instead the advantages of instruments that did not get tired or need long decompression times.

While oil drilling became commonplace, other anticipated extractive industries have not come to pass. Manganese nodules are not profitable to mine, nor is desalinization a feasible industrial-scale process. Fisheries resources declined steadily during the time period of this story, while aquaculture has been successfully instituted relatively recently, and only in inland waters, not on the continental shelf. In short, most of the imagined exploitation of continental shelf resources have not been realized.

In conjunction with the emerging environmental movement, cultural perception of the oceans changed dramatically during the 1960s, from a source of virtually endless food, minerals, and other valuable industrial commodities to an environment as prone to damage by human actions as terrestrial environments. Rachel Carson was clearly involved in this transition, starting with her first book, *The Sea Around Us*, celebrating the wonders of the ocean, and continuing with her clarion call for the health of the earth with *Silent Spring*. By the end of the 1960s, titles of popular books about the ocean evoked not frontiers but fragility, as in Wesley Marx's 1967 book, *The Frail Ocean*.[97] Although oil platforms proliferated, environmental activists fought to contain their spread. Wild dreams of vacationing undersea on a coral reef gave way to distaste for installing permanent structures in coastal waters, whether for science or recreation.

The failure of Scripps Island as a particular instance of early 1960s optimism and ambition relate also, of course, to the specific institutional context. It is possible that the project foundered in part, as some feared even at the time, because Nierenberg lacked the dynamism of Revelle. Certainly it seems clear that Nierenberg, Oversmith, and many Island committee members got caught up in the excitement and promise of ocean engineering, including its connections to industry. This represented a departure from the vision developed under Revelle's leadership, which aimed to integrate disparate branches of oceanography into a coherent, yet very broad, science of the sea. Scripps had an established history of cooperating with industry to gain funding for science, but no tradition of engineering as part of its raison d'être.

SIO failed to make a case for the vision of the future of oceanography implied by the Scripps Island facility. Oceanography as a discipline experienced a degree of solidification at this time, and leaders in the late 1960s and early 1970s felt less pressing the need for creative and distant interdisciplinary partnerships, such as with medicine and engineering. An influx of new scientists into the field, and specifically into Scripps, diluted the early enthusiasm of the original backers of this facility. Although ecology and physiology became part of the suite of marine sciences, and marine chemistry gained a powerful foothold, medicine and engineering were not closely incorporated.

Before the romance with engineering came to dominate the Island plans, the technology itself was expected to integrate and promote the new vision of ocean science. The technological system of Scripps Island would literally house investigators from different disciplines and enable their access to that part of the marine environment targeted by their field. Steeped in the optimism and hubris of the day, Island proponents expressed confidence that the Island would speed the exploitation of valuable oceanic resources and promote a new industrial sector. Possibly it would even promote a new way of life. Ocean science did not, however, prove the vanguard for colonizing a new frontier. Technology remained central to oceanography, because knowledge of the opaque seas depends on it, but ocean investigation became instead an activity devoted to understanding the ocean environment without altering it in the process.[98]

ACKNOWLEDGMENTS

I would like to thank Ronald Rainger, Christine Keiner, Deborah Day, and all participants of the Maury III Workshop for their comments and suggestions. I especially thank Day and her staff at the Scripps Institution of Oceanography Archives for their enthusiastic assistance. I am particularly grateful also to the Scripps Institution for the award of the William E. and Mary B. Ritter Fellowship, which funded my research for this chapter.

NOTES

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24. Shor, *Scripps Institution*, 168.
25. Hermann Rahn to Scholander, May 18, 1964, with proposal by Rahn and E.H. Lanphier, "An Underwater Research Institute"; Scholander and Strickland to Revelle, June 15, 1964; Revelle to Rahn, June 29, 1964, SIO, AC 6, Box 10, f. 65. Rahn and several colleagues visited Scripps on July 14th. See "Progress Report," July 21, 1964, SIO, AC 6, Box 11, f. 65.
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89. Isaacs, Acting Director, to Oversmith, December 22, 1969, SIO AC 6, Box 11, f. 7A.
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York: Houghton Mifflin Company, 1962). Wesley Marx, *The Frail Ocean* (New York: Coward-McCann, Inc.,1967).

98. Thanks to Christine Keiner, whose mention of her interest in ecology as a science that sometimes has to destroy habitats in order to study them, helped me think about the demise of Scripps Island plans. For an example of this practice, see Stephen Bocking on the Hubbard Brook Study in *Ecologists and Environmental Politics: A History of Comparative Ecology* (New Haven and London: Yale University Press, 1997), 116–150. A study of the development of the Monterey Bay Aquarium Research Institute (MBARI) might be of comparative interest (for a different time period) in the context of themes brought up in this paper. MBARI was founded by David Packard (co-founder of the Hewlet-Packard Company) in 1987 with the intention of housing scientists and engineers in the same institute, with the idea that they would work together to develop the technology to study the relatively unknown deep waters adjacent to the Institute. The Institute's location on the edge of a deep underwater canyon is strikingly similar to the location chosen for Scripps Island. The emphasis on technology is likewise strong in both Scripps' proposed facility and at MBARI. Interestingly, MBARI has a strong environmental focus.