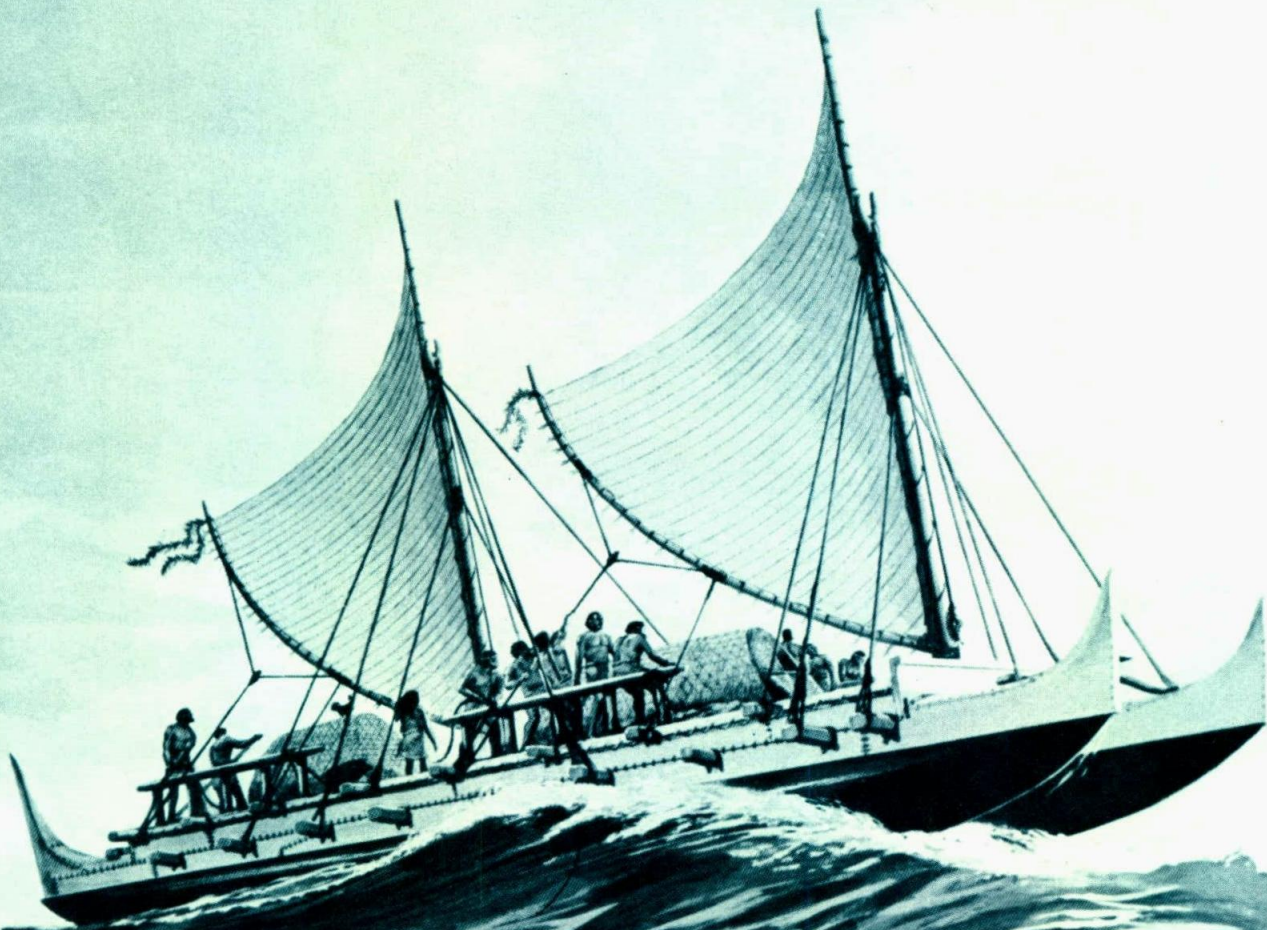




EAST-WEST CENTER MAGAZINE

SPRING-SUMMER 1976



VOYAGE INTO THE PAST

Launched with careful attention to religious tradition, this re-creation of an ancient Polynesian voyaging canoe plies the waters of the South Pacific in an effort to duplicate the supposed route of Hawaii's discoverers more than 800 years ago.

Bicentennial Voyage of Rediscovery

By Mark Zeug

It is more than an adventure, more than an experiment in seamanship. It is a planned voyage into the past in perhaps the most ambitious single event commemorating the United States Bicentennial.

While events across the country are drawing huge Bicentennial crowds who wish to catch a glimpse of the heritage that is America, a 60-foot double-hulled voyaging canoe is plying the solitary waters of the Pacific, somewhere between Hawaii and Tahiti, to document a giant piece of that heritage. Without charts, compass or other navigational instruments, the crew of the *Hokule'a* (or "Star of Gladness," the Hawaiian name for the star Arcturus that guided early voyagers to Hawaii) is attempting to duplicate the supposed route of Hawaii's discoverers more than 800 years ago.

At the same time, the Polynesian Voyaging Society, which designed and built the giant canoe (see "The Star of Gladness", page 8), hopes to re-



capture the navigational skills and spirit of old Hawaii in a dramatic experiment in cultural retrieval. The Society was founded on the belief that Polynesia began with the canoe more than 3,000 years ago.* From these canoes we can learn much about those who built and sailed them centuries before European ocean exploration began.

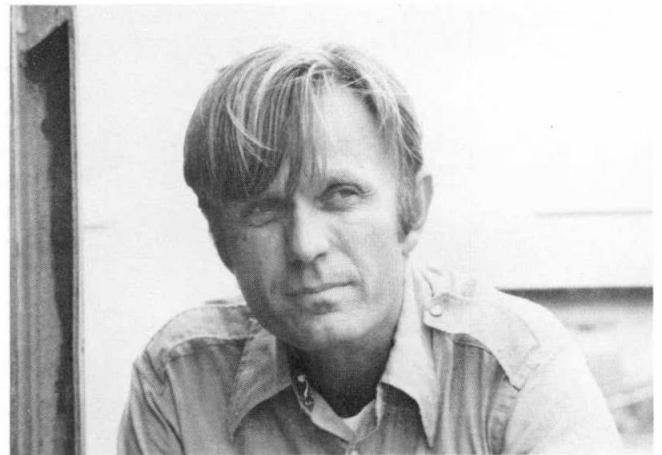
Society President Ben Finney, an anthropologist and East-West Center research associate (see "The East-West Center's Contribution", page 3), has been dreaming of such a voyage for over 10 years. He said the voyage is a planned "experimental approach to one of the most intriguing and disputed questions in Polynesian history; how were the many islands of Polynesia first discovered and settled?" Was it an accident, or was it deliberately planned?

*Archaeological evidence indicates much of Polynesia was settled before the age of the Vikings around the tenth century A.D.

While many people have believed for years that it was the result of planned two-way voyaging, the opposite view received substantial impetus in 1956 from New Zealand scholar Andrew Sharp. According to Dr. Finney, Sharp maintained that the Polynesians did not have the means to sail out to distant and unknown islands, and then retrace their course home again so that colonizing voyages could be organized. That is, for distances beyond a few hundred miles, Sharp believed any voyaging was the result of straying off course and drifting helplessly to landfall, or of exiled groups intentionally sailing off into the unknown in the hopes that land would be encountered. Once they had encountered land, they could not return to their home, since they did not have the navigational skills, or canoes of sturdy enough design, to make such a return voyage.

Finney asserts that Sharp's essentially negative assessment of Polynesian voyaging skills, and any other positive or negative judgments, are traceable to a lack of reliable data on ocean canoe performance, navigational capabilities and relevant human evaluation. Writing on "New Perspectives on Polynesian Voyaging" which appeared in Bernice P. Bishop Museum Special Publication 56 (1967), Finney notes that "until recently the only sources available on such points have been the sketchy and often ambiguous reports by the first European visitors to Polynesia," reports which can be selectively quoted to support either side of the issue, he says.

He argues that the only way to get reliable data on canoe performance and navigational capabilities was to build a replica canoe and study its behavior. It was with this in mind that he, with the help of three friends, built and tested a 40-foot double-hulled forerunner of the *Hokule'a* in 1966. From these experiments he concluded



Finney



Kane

Photo by David Hiser

Photo by David Hiser (C) National Geographic Society



Even before the *May* voyage began, the *Hokule'a* had become the inspiration for other voyaging canoes in Polynesia. Maui islanders consecrated the first last fall, the 42-foot *Mo'olele*, or "Flying Lizard," and other canoes are being planned on Kauai, Hawaii and Oahu. And the Tahitians may complete a similar canoe in time to return to Hawaii with the *Hokule'a* in August.

Hokule'a takes to the waters of Kaneohe Bay with a rumble and a rush, beginning a story that will eventually be told to national television audiences through a "National Geographic Special."

The East-West Center Contribution

An authentic voyage into the past is not possible without the expertise of different people from different places. Getting them together has not been easy.

However, the East-West Center has taken a major role in facilitating this important aspect of the voyage, using its mechanism of supportive grants to be involved in one of the largest local cultural activities of the decade. In addition to the staff commitment of two institutes, the Center has provided eight-month fellowships to two of the principal resource people, and awarded professional development grants to three others playing prominent roles in the voyage.

Major Center input is organized through the East-West Technology and Development Institute and its Regional Development in the South Pacific project. This project is directed in part by Research Associate Ben Finney (who also holds a joint appointment as professor of Anthropology at the University of Hawaii), one of the principal organizers of the Polynesian Voyaging Society and its president for the past three years. Further Center input is organized through the Cultural Identity subdivision of the East-West Culture Learning Institute, and limited staff commitment from Research Associate Gregory Trifonovitch and Program Officer Kenzi Mad.

Senior Fellows

Two people who, with Finney, have made major contributions to the voyage are currently on eight-month Senior Fellowships at the Center. Herb Kawainui Kane, a renowned Hawaiian artist and expert on Hawaiiana, is a Senior Fellow in the Technology and Development Institute. Kane, along with naval architect Rudy Choy, designed the *Hokule'a* and supervised construction. In addition, he has written several articles on the cultural significance of the voyage (the latest appeared in the April issue of *National Geographic Magazine*), and has made similar presentations to local schools and community groups. He will collaborate with Finney in writing a book about the journey later this year.

Physician-mariner David Lewis of New Zealand, author of the University Press of Hawaii book *We, the Navigators*, is a Senior Fellow in the Culture Learning Institute. Lewis has spent many years researching the principles of non-instrument navigation in the Pacific, and briefed the crew on its rudiments before the voyage. He also worked with master navigator Pius "Mau" Pailug of Satawal Atoll in Micronesia on the star courses of the Hawaii-Tahiti route. Lewis is taking part in the voyage both as physician and as navigation researcher. He will write the *National Geographic* story about the voyage itself, and is completing a monograph on indigenous navigation systems of the Pacific for the Center.

Professional Development Participants

Pailug's participation was made possible through an eight-month grant from the Culture Learning Institute. He hails from one of the last areas of the Pacific where non-instrument navigation is still practiced as a way of life. As a veteran seafarer and navigator in the Carolines but a virtual newcomer to Hawaii-Tahiti waters, Pailug worked long hours with Lewis in "mapping" out *Hokule'a's* route. He also supervised much of the lashing required to rig the canoe for the voyage, and is sharing this lore through the Institute's museum management project.

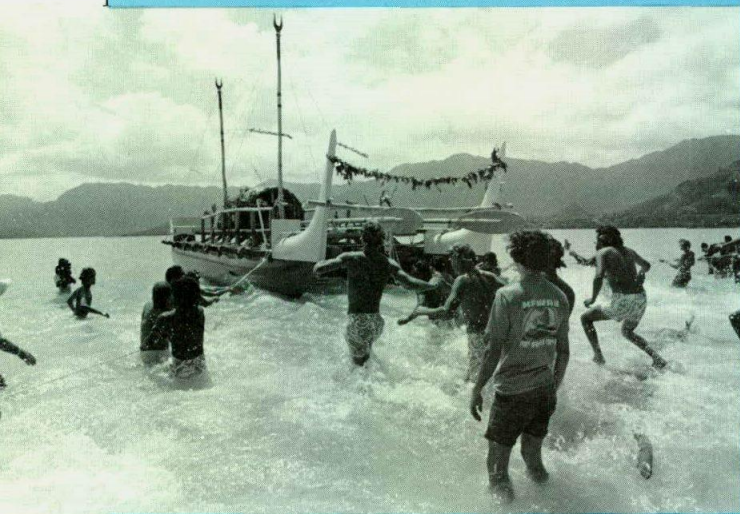
The Center also provided an eight-month professional development internship to Rodo Tuko Williams of Tahiti, a veteran sea captain with many years experience piloting schooners and fishing boats through the treacherous Tuamotu atolls and reefs that lie across the route. His grant was provided through the Technology and Development Institute.

A similar grant was awarded to Kimo Hughon, Honolulu fireman and veteran canoe racer who assisted with crew training, and will be one of the leading crew members on the voyage. Before the mid-April departure, he lectured extensively about the project and its cultural significance to Hawaii school children. He also serves with Finney, Lewis and Kane on the Board of Directors of the Polynesian Voyaging Society.

East-West Center Vice President John Brownell estimates the Center's commitment to these participants and their activities at about \$26,000 in grants alone, plus additional costs in staff time.*

"The cultural significance of the voyage, along with the scientific nature of experiments involved, makes it a natural concern of the Center," he said. "It is multi-national, multi-cultural and multi-disciplinary. And it involves extensive institutional and community cooperation. All these add up to increased cultural understanding, and that's what we are all about."

*Only one other individual or institution has contributed more to the *Hokule'a* project than the Center: Penelope Gerbode-Hopper of San Rafael, California, and a member of a prominent island family. Other substantial contributors are the Hawaii Bicentennial Commission and the National Geographic Society.



that two-way voyaging to Tahiti was possible under sail, but that extensive paddling on such a voyage would have to be ruled out.

Finney cautions that his experiments do not prove or disprove the historical supposition of two-way voyages, merely that they were possible. Even the successful (or unsuccessful) voyage of a larger oceangoing canoe to Tahiti and back would not prove (or disprove) that supposition, but it would certainly dramatize the possibility and reawaken a sense of self-esteem among Hawaiian-Americans.

That's where the Polynesian Voyaging Society came into the picture. In mutual discussions with Hawaiian artist Herb Kawainui Kane and Honolulu scientist-surfer C. Thomas Holmes, who both shared Finney's ambition, the idea developed for the formation of a non-profit society that could solicit the support needed for building and sailing such a canoe to Tahiti and back. These three chartered the Society in 1972 and began to plan the voyage and solicit membership.

As background for the experiment, they analyzed Finney's previous trials, and studied a computerized simulation by University of Minnesota scientists. By computing ocean current and wind directions, the Minnesota researchers concluded that a drifting canoe from either the Marquesas or Tahiti would not reach Hawaii—tradewinds and currents would push it far to the west. Reaching Hawaii from the south requires deliberate aim, they stated.

Further, the Society members noted archaeological and linguistic evidence which supports the theme of many Hawaiian and Tahitian chants that this two-way voyaging actually took place some 500-800 years ago. Polynesian voyagers were settling in the Marquesas and Society Islands around the time of Christ, according to Kenneth Emory, Polynesian anthropologist at the Bishop Museum. From these islands, in great double canoes like the *Hokule'a*, the ancestors of the Hawaiians "discovered" these islands and established settlements here—from the Marquesas around 500-750 A.D., and from Tahiti around 1300 A.D.

An ancient Hawaiian tradition, which refers to two-way voyages over a span of generations, tells of a voyaging departure through a passage known as *Ke-ala-i-kahiki*—the route to Tahiti. (The southwest point of Kahoolawe still retains this name, though there is no evidence that more than one voyage may have actually left from there.) Even the name Hawaii is Tahitian in origin, derived from Havaiki, the old name for the second largest of the Society Islands, Raiatea. This island seems to have been the cultural center of the Societies during the time of the Tahiti-Hawaii voyages, according to Kane.

Now a Senior Fellow with the East-West Technology and Development Institute, Kane asserts that the voyaging canoe lies at the heart of Polynesian culture—without it there would be no Polynesia. The Society Islands lie

(Top) Captain Kawika Kapahulehua, a veteran catamaran skipper, received official leave from Western Airlines to supervise renovations and pilot the canoe to Tahiti and back.

*(Center) Kenneth Emory, dean of Polynesian anthropologists, watches the *Hokule'a* launching with Sam Ka'ai, who models a rain cape of dried pandanus leaves.*

(Bottom) Physician-mariner David Lewis gives an impromptu lesson on non-instrument navigation to crew members.

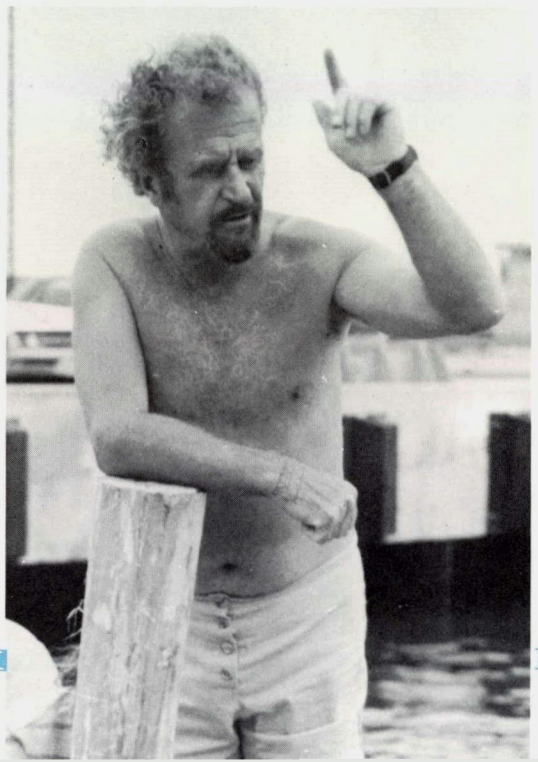




Photo by David Hiser



Pialug

near the Center of Polynesia (or "many islands"), a triangular area of the Pacific from New Zealand to Easter Island to Hawaii. In huge voyaging canoes, some nearly 100 feet long, designed by men who had no knowledge of metal, Hawaii's forebearers completed the settlement of this area, which Dr. Emory asserts began around the 12th century B.C. in Tonga.

By the time European explorers reached the Pacific, they found to their astonishment a viable society on every habitable island in Polynesia whose members paddled out to greet them. When considered in the context of the time, Kane believes the skills and know-how of these pathfinders were comparable to that needed to land a man on the moon today.

Kane notes, however, that the impact of Western technology, with its metals and gunpowder, dealt a fatal blow to Polynesian self-esteem and led to the disintegration of Polynesian culture. Emory, dean of Polynesian anthropologists, pointed out that lack of confidence in their culture has caused Hawaiians to abandon features which played a significant role in their lives. When an important central object, such as a voyaging canoe, is allowed to disappear and be forgotten, all useful culture associated with it disappears as well, he says.

It was this frustrating situation which prompted the founding of the Polynesian Voyaging Society. Its charter states its purposes:

- 1) to sponsor or conduct, or both, research on the manner in which Polynesian seafarers settled Hawaii and other Pacific Islands by investigating through experimental and other means the canoes, navigation systems and other technical and cultural factors that enabled the Polynesians to undertake successful voyages of discovery and settlement,
- 2) and to disseminate the resultant research findings by producing or publishing, or both, articles in scientific journals, books, films and other instruments of

Trouble beset the Hokule'a on a training cruise from Kauai to Oahu last fall, when one hull swamped in choppy seas. Crewmen struggled to save the canoe by lashing all movable deck objects to the opposite side to prevent capsizing. The "fortunate accident" was followed by extensive renovations before the May departure to Tahiti.

communication in order to inform the public about Polynesian voyaging, and to make available data that might be useful to scientists and others engaged in maritime endeavors.

Even before the voyage of the *Hokule'a* began in April, the Society's members were well on their way towards accomplishing both goals. Before departure, the *Hokule'a* had logged over 1500 ocean miles on limited maneuvers in Hawaiian waters. More than 100 Hawaii islanders learned to sail as their forebearers did on these maneuvers, making the *Hokule'a* a "floating classroom in Hawaiiana," a role she will resume upon return from Tahiti in August.

Various aspects of her exploits have been written in publications throughout Hawaii, and the *National Geographic Magazine* has twice focused on Polynesian voyaging (December, 1974 and April 1976). A complete written account of the voyage will appear in *National Geographic Magazine* this fall. In addition, the National Geographic Society is filming this voyage in preparation for a "National Geographic Special" to be offered for nationwide television screening.

These accounts will contain results of the many experiments involved, from the proficiency of the crew to the efficiency of the many traditional foods that were taken along, the live animals and plants and the success of non-instrument navigation. Finney, Holmes and David Lewis will be closely monitoring these factors.

But most of all, the voyage will chronicle a period in Pacific history when men and women coped with an appallingly meager environment to accomplish one of the greatest feats of mankind. □



Tevake of the Santa Cruz Islands, one of the last Polynesian navigators, was one of David Lewis' tutors. In 1970, sensing he would soon become a burden to his family and friends, Tevake bade them farewell and paddled out to sea in a small canoe. He was never seen again.

Steering by the Stars:

Rediscovery of a Lost Art*

At a time when Europeans were still deathly afraid of venturing too far from unknown territory, Polynesian pathfinders were fearlessly exploring the length and breadth of the world's largest ocean. When the European explorers arrived in the Pacific, the Polynesians paddled out to meet them.

How did these tall, brown-skinned people manage to colonize every habitable island within a 15 million square mile area without the use of metals, compass or navigational charts? The true answer was very nearly lost forever.

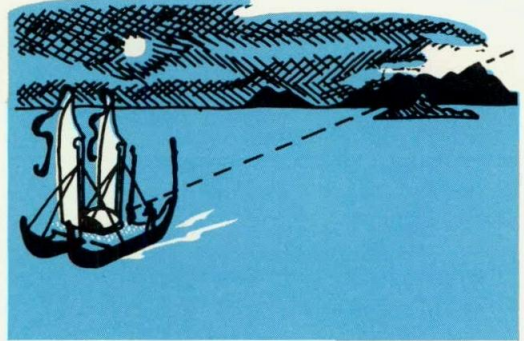
For decades scholars have speculated about the navigational ability of the Polynesians, but no definitive study was ever conducted on how non-instrument navigation was accomplished. Physician-mariner David Lewis of New Zealand set out in 1965 to find out how they did it many centuries ago. He found, to his astonishment, that there were still a few present-day practitioners of the ancient art left in the Pacific, primarily in Micronesia (probably because it felt the impact of European inventions nearly a century after the South Pacific). European contact had caused seafarers to turn to the compass and other navigational instruments of recent development. Yet Lewis knew that no navigational instruments or artifacts of any importance are recorded as ever having been used at sea in Oceania.

Lewis' search took him to the Santa Cruz Islands where he met Tevake, and to the Carolines where he met Hipour, two of the half dozen men who would become his tutors in non-instrument navigation. The classroom was the open ocean, with all charts and instruments locked up and unavailable. The test was his ability to see and feel the naked environment as his tutors saw it.

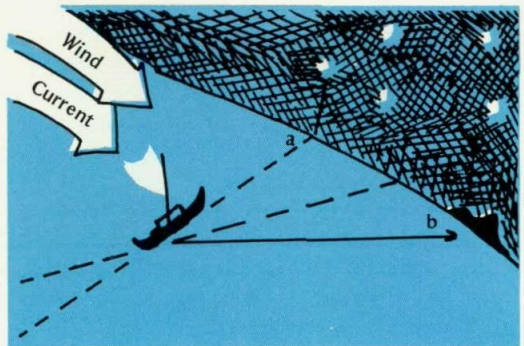
Lewis compiled the results of nearly 10 years' research into a book entitled *We, The Navigators* (University Press of Hawaii 1972). In it he details an ancient art known only by a few, for the navigational secrets were kept within respected families of old Polynesia. These navigators knew the rising and setting positions on the horizon of more than 150 stars, and used them as a compass. They knew the behavior of the ocean so well they could sense differences in ocean swells literally through the scrotum. Living close to nature and being sensitive to all natural phenomena, they epitomized the Polynesian view of the sea, not as a terrifying adversary, "but the friendly bosom of one of their god ancestors, Tangaroa," says Herb Kane. Writing in *Canoes of Polynesia*, (Island Heritage Books, 1974), Kane noted that "while other men feared to leave their coastal waters, Polynesians faced the open sea as their own and only world. Their gods were gods of nature, man's own ancestors who bestowed strength and success on those who trimmed their sails—and their lives—in harmony with natural forces. In this primitive ecological point of view, the European fear of nature and obsession with a 'conquest' of nature would have seemed arrogant beyond comprehension and certain to bring disaster."

Kane and Lewis, now East-West Center Senior Fellows (see "East-West Center Contribution", page 3), have collaborated on a number of Polynesian voyaging works, and the following have been compiled from those works. Drawings are taken from art by

Adapted from *National Geographic Magazine* with permission.

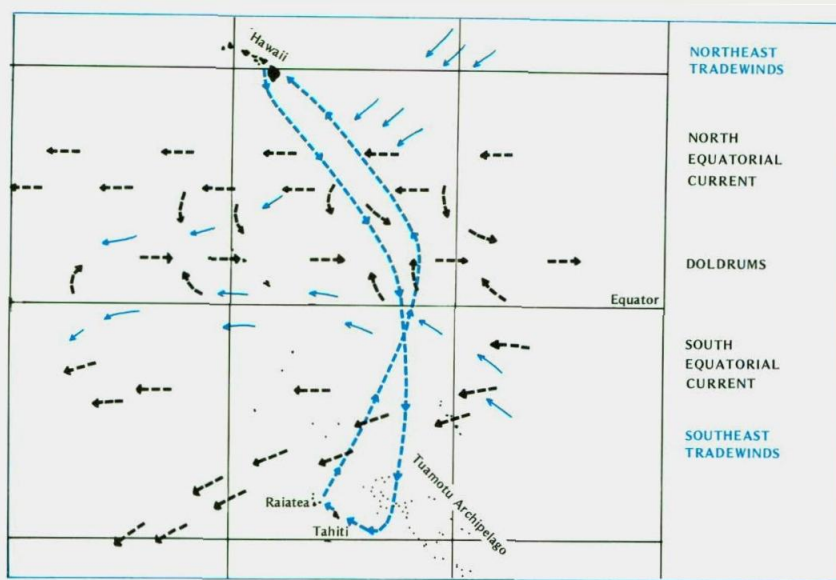


By embarking at sunset, a navigator could set his course by keeping two mountain peaks in line astern—drift away from the alignment would tell him direction and strength of current. As dusk fell and these landmarks faded from view, the navigator turned to steering by the stars.

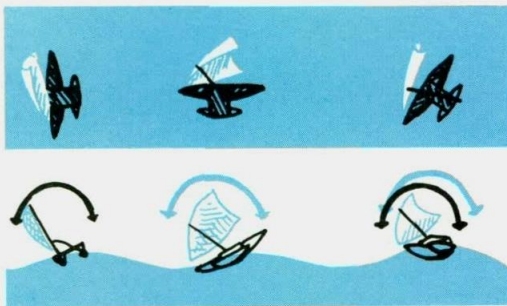


Navigators steered toward stars known to rise over their destination, a process usually complicated by wind and current. Once the wind and current were known, however, the navigator would "correct" for this drift by selecting a star (a) to the left or right of his destination (b) at approximately the angle of drift.

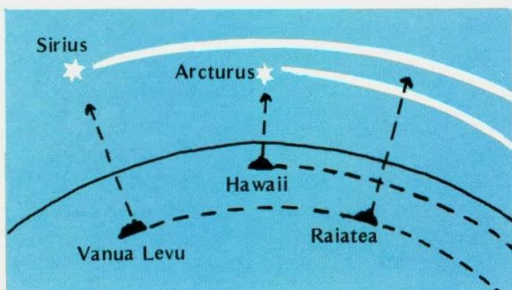
*From the titles of the first two chapters of *We, The Navigators* by David Lewis (University Press of Hawaii, 1972).



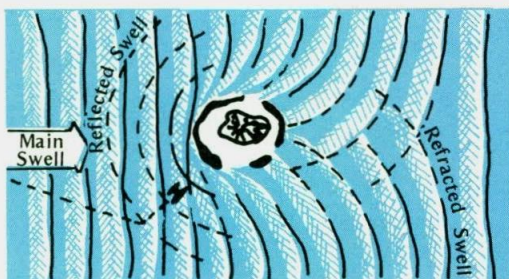
To reach Tahiti, the *Hokule'a* must first sail southeast, with the prevailing trade winds and current to port. As it reaches the equatorial doldrums (calm winds), the equatorial counter-current probably will carry it further east until southeasterly trades fill its sails near the equator. It can then sail at right angles to wind and current on toward Tahiti, through the treacherous Tuamotu Archipelago until the navigator obtains a zenith star position on Sabik. Whereupon it can turn downwind and make landfall. A similar strategy in reverse will be followed on the return trip.



Generated by distant winds, great undulating swells pulse the ocean for thousands of miles, allowing the navigator to maintain direction by keeping the degree of pitch (a), roll (b), or combination of the two (c), at a constant ratio.



Stars which pass directly over certain islands when at their zenith gave voyagers an island's latitude. By approaching upwind until a zenith star was directly overhead, the navigator could then turn downwind to his destination.



As he moves downwind, the navigator will be looking for reflected ocean swells from the yet unsighted island. By detecting the angle of the reflected swell, he can turn to that angle and make landfall.

Kane as detailed in a December 1974 supplement to *National Geographic Magazine* entitled "Discoverers of the Pacific," adapted here with permission.

Unlike the modern navigator whose instruments allow him to fix any position without reference to place of departure, the Polynesian navigator's system is home-oriented. He keeps a mental record of all maneuvers and elements which affect position, and retraces these in his mind so that at any time he can point in the direction of home and estimate the time required to reach it.

By departing in late afternoon, and keeping two mountain peaks or offshore islands, or even two signal fires, lined up with the stern, the navigator could switch to starpath navigating about the time his home island dropped from sight. Then by keeping a succession of stars, rising or setting on the horizon, lined up with the bow, he could continue to move in a desired direction. As each star rose too high to be useful, or set out of sight, a following star would be selected. By not moving from his station, an experienced navigator could keep his canoe aimed at a constant heading, compensating for current and wind almost automatically.

As the last star faded, or the sky became overcast, the navigator would take note of the ratio of pitch and roll caused by dominant swells, maintaining course by keeping the ratio constant until another celestial bearing could be taken.

Determining latitude (distance away from the equator) utilized perhaps the most constant aspect of non-instrument navigation—zenith star sightings. As the earth rotates, certain stars pass directly over certain islands at a given time of the year. The early navigators knew the zenith star identities for every major island or group. Once latitude had been determined, a canoe would be turned downwind to make landfall.

By looking for land-formed clouds, island-based fishing birds, different sky and water colors, and the intersections of ocean swells reflected from islands, navigators could expand their landfall target 30 miles or more beyond actual land sighting. Since nearly all Pacific islands are part of larger island groups, a navigator need only aim at the center of the group and, after sighting familiar land, change course to a specific island. Using these methods the Hawaiian Islands present a north-south target of nearly 700 miles, the Society Islands (Tahiti) nearly 400 miles.

On its voyage to Tahiti, the *Hokule'a* will be seeking latitude alignment by the star Sabik (Tahiti's normal zenith star, Sirius, is not visible during the night this time of year). As the *Hokule'a* returns to Hawaii and obtains a zenith star alignment from Arcturus, it will turn downwind and, using a series of tacks to expand its landfall area, probably sight the unusually high cloud patterns which surround the big island of Hawaii—sometime late in July.

The 6,000 mile round trip represents the longest voyage by a vessel designed for experimental archaeology, that is, the reconstructing and testing of ancient technology. The Hawaii-Tahiti route itself represents the longest two-way navigational route of old Polynesia. □



The Hokule'a shows her size and stature as she returns to water after renovation.

"The Star of Gladness"

There is nothing primitive about the design of the *vaka taurua*, the Polynesian double-hulled canoe.

Designed by Polynesian seafarers over 800 years ago, the double-hulled canoe can hold its own with modern sailing vessels of similar size, according to the designer of the *Hokule'a* ("Star of Gladness"), Herb Kawainui Kane. Kane says his admiration for the ancient inventors of this craft "is beyond measure; for with few materials and no metal whatsoever, they built seaworthy vessels which were sophisticated far beyond their time. On a reach off the wind, the *Hokule'a* is faster than single-hulled conventional yachts of equal length, though the latter may be carrying twice as much sail. Being without a jib, she is slower going to weather, and she may be slightly slower on a run than a yacht with a big spinnaker, but that has not yet been tested."

In addition, Kane asserts that the 60-foot replica of early *vaka taurua* rides very smoothly because the shock

of the waves against the hulls is absorbed by the cross-boom lashings. The stability of the double hulls allows for more accurate navigational sightings and considerably larger carrying capacity than single-hulled craft.

A great deal of research went into the design of the 13th century re-creation in order to make its performance as close as possible to what the early Polynesians probably experienced, Kane says. The principal design features have been derived from details of voyaging canoes observed and described (and sometimes drawn) by early European visitors to Polynesia. Other bits of information about hulls, sails and design were combined into the *Hokule'a*.

The canoe has an overall length of 60 feet, a beam of 15 feet, and each of the two hulls is three and a half feet wide by five feet deep. Ten crosspieces, each 17 feet long and weighing 185 pounds, and many thousands of feet of quarter-inch line, hold the two hulls firmly but flexibly together. The canoe weighs about five tons and can carry up to seven and a half tons of people, food, water and supplies. At this load the hull draws two feet of water.

The canoe hulls were made primarily from modern materials, except for the upper gunwale portions, which were made of fitted and lashed planks in a manner similar to tradition. However, in size, shape and weight, the hulls duplicate what Kane believes are the basic characteristics of ancient hulls. Thus, when it comes to

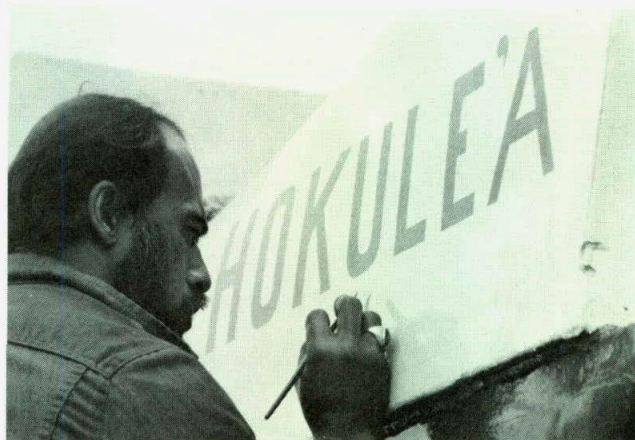
performance, a close approximation to ancient canoes can be assumed.

Two portions of the canoe where the nature of materials may affect performance are the sails and the material used for lashing. Here the Society enlisted the help of villagers on Nanumea in the western part of Polynesia who braided five miles of coconut fiber rope (sennit) and wove the pandanus leaf sails needed for the voyage.

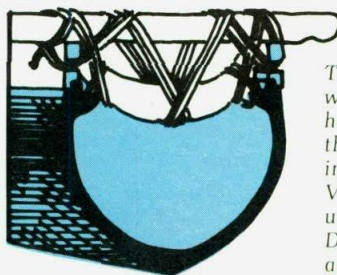
While the canoe was built at the Dillingham Shipyard in Honolulu, it was trucked to Kualoa on the windward side of Oahu for launching, a place once considered so sacred that the canoes of the time lowered their sails when they passed. This attention to religious ritual is consistent with ancient times, when the building of a canoe was a religious event, marked by prayers, ceremonies and feasts.

Canoes were instruments of purpose and fulfillment, Kane says. Each canoe was named and treated as a living member of the community, an integral part of an orderly universe. Building an important canoe was a community project in which entire villages turned out to help haul rough-carved hulls and lumber down from the mountains to the canoe yards. Children gathered the long pandanus leaves and cured them, and their mothers plaited them into sails. Old men braided miles of the coconut fiber rope used to lash the boat together, and high chiefs slept in the hulls so their personal power might flow into the vessel. The launching ceremony was an occasion for a community-wide feast.

These canoes, in turn, probably exerted a profound shaping influence on their makers as well, to an extent unparalleled by any other artifact ever made by man. Favored for survival were persons with powerful muscle, stamina and ample fat to sustain the body through times of hunger, and insulate against deadly exposure to wind and spray. Since the survivors of a voyage formed the ancestor-pool for a newly discovered island, this process of natural selection undoubtedly accounted for the large stature of Polynesian people. They were truly children of the canoes. □

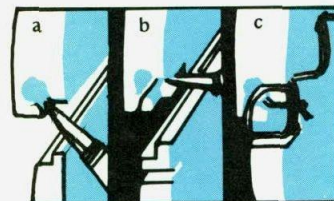


Kimo Hugho puts the finishing touches on "Hokule'a," the "Star of Gladness."



The Hokule'a was designed with a rounded "V" shape to its hull, contrasting sharply with the U-shaped hulls used for inland voyaging, and the V-shaped hulls more commonly used for open ocean voyaging. Designer Kane says this appears true to ancient designs, though no actual hulls are retained from the 13th century.

The hulls were usually made from a single log, though no log large enough for the Hokule'a could be found in modern Hawaii. Gunwale planks were lashed to this log in a



complicated and ingenious manner involving chiseling cavities along the bottom of the plank (a), then drilling holes from the side and bottom to meet these cavities (b). When matched with similar holes in the hull and lashed securely, the gunwales provided additional hull depth. Breadfruit sap served as caulk.



As sleek and graceful as a modern-day racing yacht, the Hokule'a measures 60 feet long, 15 feet wide, and weighs four and a half tons.