THE VAEAKAU-TAUMAKO WIND COMPASS AS PART OF A "NAVIGATIONAL TOOLKIT"

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Different voyaging communities in the Pacific use a variety of non-instrument navigational techniques for way-finding across long distances. The use of a star compass has been well documented for several groups. Wind compasses are less well documented and appear to be less utilized throughout the region. This article seeks to understand the Vaeakau-Taumako wind compass as it compares to other wind compasses, as well as how wind and star compasses and other navigational techniques compare to each other as cognitive frameworks for navigation.

Key Words: wind compass, navigation, Polynesia

Introduction

Like magnetic and star compasses, a wind compass is a cognitive construct.[1] It uses an abstract representation of space in which the circular horizon is divided into a finite number of named, discrete, and systematically spaced points. Star compasses are well described for much of the Pacific, where voyagers depend on them for inter-island way-finding. Similarly, navigators on a number of Pacific islands report heavy reliance on wind compasses. Yet, surprisingly, little has been written about them. Here, we examine one wind compass system, thereby addressing an important lacuna in the understanding of Pacific Island voyaging and navigation. This article first reviews the extant knowledge of Pacific star and wind compasses. It then describes a wind compass developed and used in the southeastern Solomon Islands. Finally, it explores how that wind compass relates to a broader set of concepts and practices that we term a "navigational toolkit."

This discussion is set in the Vaeakau-Taumako region of the Solomons' Temotu Province. Vaeakau and Taumako are part of a larger group known as the Santa Cruz Islands, which include the high islands of Vanikoro, Utupua, Ndeni, and Tinakula volcano, the Reef Islands north of Ndeni, and Taumako or the Duff Islands, about eighty miles to the northeast of the Reefs. The islands locally termed Vaeakau are known in English as the "Outer Reefs." They are culturally separate from the main Reef group; their people, along with those of Taumako, speak a Polynesian language and think of themselves as part of Polynesia. People in the rest of the Santa Cruz Group are Melanesian and speak what have been called aberrant Austronesian languages (Pawley 2006). The Santa Cruz Islands have been recognized for decades as a center of inter-island voyaging and trade (Davenport 1962, 1964; Lewis 1972), and as far back as 1606, the explorer Quiros commented on the region's seagoing canoes (Markham 1904; Leach and Davidson 2008). Until well into the Twentieth Century, Taumako craftsmen built large voyaging canoes on order from Vaeakau sailors. The Vaeakau would then sail the canoes to the high Melanesian islands where they would trade fish, turtles, nuts, and sometimes women for "red feather money" (Davenport 1964). They then used the feather money to compensate the Taumako craftsmen, and the Taumako used the feather money in a variety of ceremonial exchanges, the most important probably involving bridewealth payments. The Vaeakau and Taumako communities speak dialects of a common language, and they share a common set of navigational practices and understandings.

By the 1960s, older craft and voyaging techniques had almost disappeared from the Santa Cruz region, but a number of men—and a few women—remembered sailing in their younger days. Basil Tavake, a renowned navigator from the Vaeakau island of Pileni, was one of David Lewis's key informants (Lewis 1972), and Crusoe Kaveia, a Taumako man who spent much of his childhood on Pileni, devoted the last decades of his life to reviving what he regarded as traditional canoe building and navigational practices. In 1980, Kaveia oversaw construction of a sailing canoe (*te puke*) and navigated, without instruments, from Taumako to Vella Lavella in the western Solomons. In the 1990s, Kaveia, in collaboration with Marianne George, created the Vaka Taumako Project with the objective of teaching his skills to a younger generation of seafarers. Data for this article were collected by Feinberg during a field study of Taumako in 2007-08.

Austronesian Star and Wind Compasses

The best known star compass is that of Micronesia's Caroline Islands (Goodenough 1953; Gladwin 1970; Lewis 1972; Dodd 1972; Frake 1995). This is a representation of the horizon over which is superimposed a map of the stars, with an emphasis on their rising or setting points. It is not an exhaustive mapping of the nighttime sky, but a configuration of navigationally relevant asterisms.[2] The Carolinians have thirty to forty named asterisms (Goodenough 1953), and it is their placement in the sky rather than the intensity of their glow that determines their value.

Gladwin (1970) observed that the Carolinian star compass has thirty-two bearings that correspond with stars on the horizon. This is the same number of bearings on the European mariner's compass—probably reflecting the limits of human perceptual and cognitive capabilities (Frake 1995:156). Unlike the mariner's compass, however, the Carolinians' star points are not equally spaced. The compass' eastern and western hemispheres are mirror images: the stars that rise in the east are the same stars indicated in the western sky where they set. As a result only sixteen named stars appear on the compass.

Although Gladwin characterizes the cardinal direction for navigators on Polowat as east, the direction of the rising Altair, arguably the most useful star is the North Star (Polaris). While it is harder to see, it does not move and is found close to the horizon. To the south is the Southern Cross, which creates a predictable arc across the southern sky, with the long axis always pointing very near to the celestial South Pole (Levy 2005:87).

Because the Carolines are mostly aligned parallel to the equator, Altair plays a significant role as a bearing, a back-sighting, and a zenith star. From Polowat, Altair is the bearing for such destinations as Satawal (to the west) and Chuuk (to the east). It rises seven degrees north of the equator, the same latitude as Polowat itself, making the bearing of Altair from Polowat due east and west, and creating an arc that passes directly overhead.

In addition to the stars identified on the star compass, myriad others comprise star paths—sequences of stars all pointing to the same destination. The star path is different for each pair of islands, and in order to be an accomplished navigator, one must recognize the sequence for any island pair in both directions. On Polowat, Gladwin (1970:131) recorded directions for "fifty-five commonly made journeys," and he notes that navigators are familiar with many more.

Polynesians, like most voyagers, have found stars to be navigationally useful. They have made (and sometimes still make) use of star paths (Lewis 1978:18; Feinberg 1988:113) and, most likely, zenith stars (Irwin 1992:48). According to Lewis (1978:34), "Zenith star estimation had once been one of the cornerstones of the more sophisticated branches of Polynesian navigation." By contrast, the existence of a star compass among early Polynesians cannot be definitively affirmed. Many Polynesian islands lie well to the north or south of the equator, and traveling from one Polynesian island to another can involve significant changes in latitude, making star mapping for a long distance voyage difficult. Lewis (1978:75), quoting the Tongan navigator Ve'etutu, observes "You must know the stars for each season, because in six months they will all be different from the ones you see now." As with other Polynesians, for Vaeakau-Taumako voyagers no single natural phenomenon reigns supreme; rather, many phenomena are used either separately or in tandem. The challenges of blue water navigation prompt a variety of cultural solutions for dealing with the problem at hand (Ingold 2011).

Like the star compass, a wind compass is a mental representation of the surrounding horizon with corresponding known wind patterns. Although winds can vary from the predominant pattern, usually it is not for long. Still, the impermanence of wind requires regular checking against other indicators such as ocean swells, land sightings, and the sun and stars (Lewis 1972). Both the predictability and the impermanence of trade winds can be used to the sailor's advantage, as a shift in direction can be critical for round trip voyages as well as one-way voyages of exploration from west to east (Finney 1985; 1994; Feinberg 1986; Irwin 1992).

Ethnographic accounts of wind compasses are sparse. Most communities that may have used them in the past have lost much of their seafaring heritage. And those who have robust ongoing seafaring heritages seem not to have much use for them. Nonetheless, they have been documented for a number of communities, e.g., Anuta (Feinberg 1988); Bugis (Ammarell 1999); Nukumanu (Feinberg 1996); Tokelau (Burrows 1923); and Vaeakau-Taumako (George 2012; Vaka Taumako Project 2011; Feinberg and Genz 2012).

Lewis (1972) offers a fair explanation of what wind compasses are all about. He reminds us that tropical Pacific winds are reasonably steady in their direction and, for the most part, predictable. In addition, they have distinct characteristics involving such features as moisture content, temperature, and accompanying cloud formations, which navigators can use to confirm their point of origin (Lewis 1972, 1978; Finney 1994). Lewis notes that winds are less permanent than the stars, sun, landmarks, or swell patterns and, therefore, are typically used as a secondary indicator of approximate direction. Those who navigate by the wind need to validate their readings by checking against other, more permanent, phenomena. Yet, sailors must be cognizant of wind direction and keep track of any shifts. Those who use a magnetic compass are able to compare these shifts to the points on their compass, while those without instruments use the swells, the sun, or the stars to distinguish changes in wind direction. Lewis (1972:133) quotes a Tikopian navigator who says "If the wind changes, I feel it by my boat on the waves."

Indo-Pacific Wind Compasses

Before examining the Vaeakau-Taumalko wind compass, we briefly review what is known of such constructs from elsewhere. Wind compasses have been described for Indonesia, Fiji, Micronesia, and Polynesia. Boerger (n.d.) discusses wind compasses in Natügu and other Melanesian languages of the eastern Solomons. To date, no published accounts are noted from Melanesia. Most of the extant data are from Polynesia, and Boerger surmises that the Melanesian wind compasses in her survey were originally borrowed from nearby Polynesian communities. Moreover, much of what has been written about wind compasses is sketchy. In many cases, these cursory accounts are all that remain of older navigational systems, as seafaring expertise has been a common casualty of outside influences. Some of the better-known wind compasses are described below.

Indonesia

The Malay wind compass (Figure 1), used by the Bugis of Indonesia, is a sixteen-point directional compass, rooted in the opposing monsoon winds (Ammarell 1999). Typically, the names of winds correspond with their direction of origin. Its users describe it as an encircling horizon with eight evenly spaced sets of opposing directions. They perceive the cardinal directions as primary, the points equally spaced between the cardinal directions as secondary, and the points between the primary and secondary to be tertiary, much like the magnetic compass. The functions of the wind compass are two-fold: "to identify the direction of the wind at sea and to describe the course and heading of a ship" (Ammarell 1999:98). Bugis sailors employ four systems for naming wind directions; two are contingent and two are absolute. Both of the contingent directions are used when naming

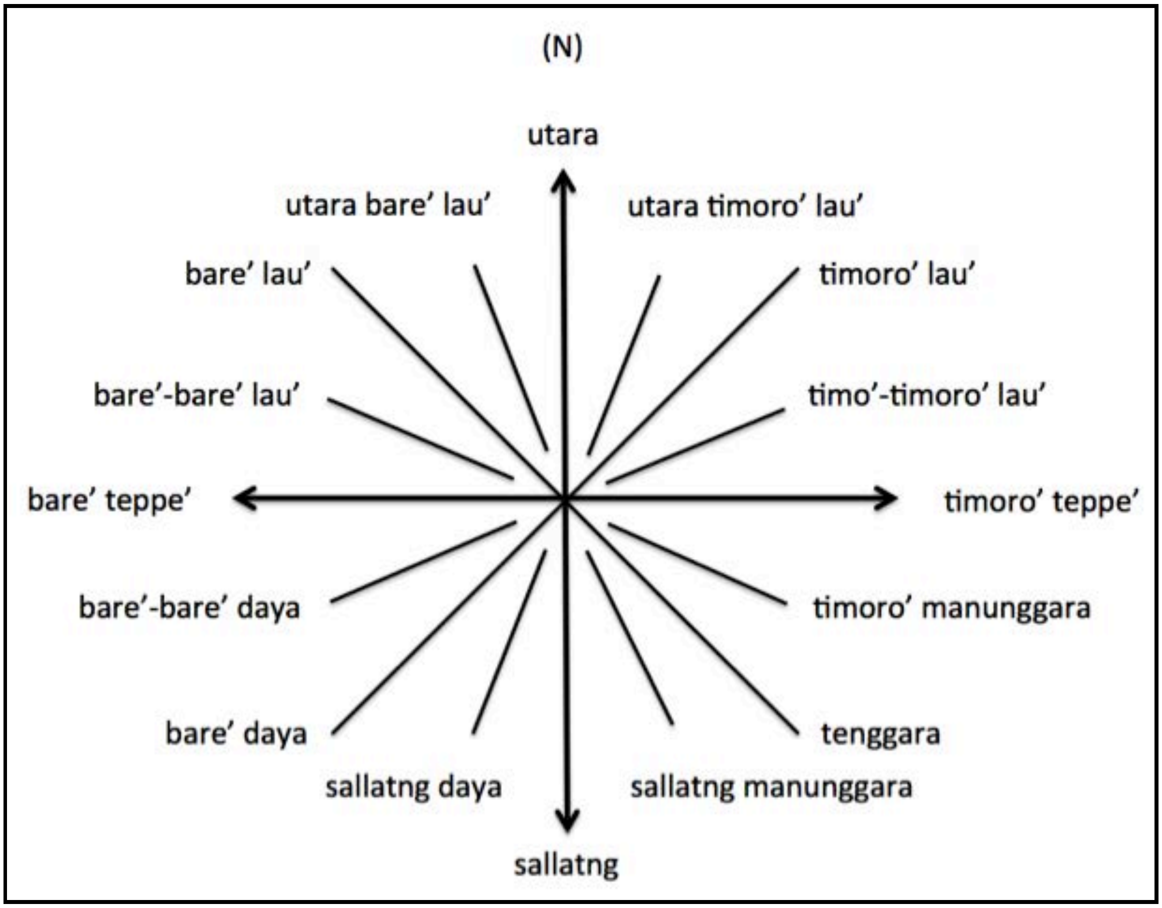

Figure 1. Malay Wind Compass (adapted from Ammarell 1999:98).

winds at sea. One is used by a sailor saying, for example, "just left of north," to describe the direction of the wind while on board the ship. The other is used to describe the wind in relation to the individual on the ship, such as "a wind from behind." The two absolute directions are used to indicate the heading of the ship ("just west of north") or while on land to describe the direction of the wind. To the outsider, this array of naming conventions may appear perplexing; to the Bugis navigator, it is clearly delineated.

Fiji

Lewis (1972) reproduces a Fijian wind compass (Figure 2) drawn by the missionary, Fr. Neyret. In addition to the erratically spaced six points on the compass, it contains three evenly spaced "sectors." According to Lewis's (1972:114) translation of Neyret, the terms on the wind compass "refer to the names of winds originating in the sectors and have been secondarily applied to the sectors themselves."

Micronesia

Although much has been written about Micronesian navigators, little has been said of their use of a wind compass. Fr. Cantova, a Jesuit priest who went adrift in the 1700s,

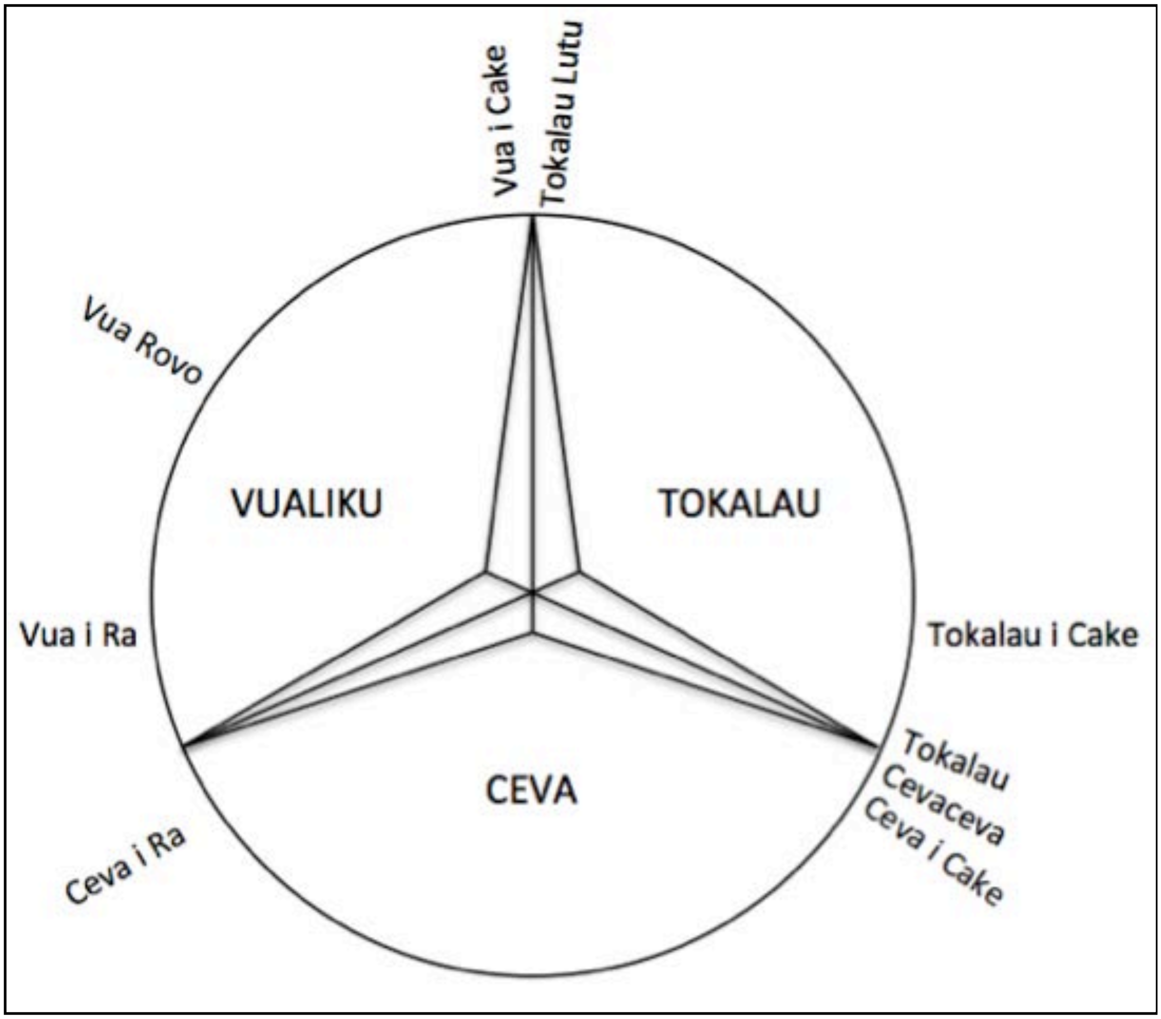

Figure 2. Fijian Wind Compass (adapted from Lewis 1994[1972]:115).

wrote about the use of a twelve-point wind compass in the Marianas, but his brief account offers little detail (Cantova 1728:209-210; Lewis 1972:73).

Polynesia

Most of the Polynesian Triangle lost its navigational heritage as a result of colonialism. However, there is evidence that navigators from several Polynesian locations (including the Cook Islands, Pukapuka, Tahiti, Tokelau, Tonga, Anuta, Tikopia, and Vaeakau) may have used a sort of wind compass.

One example is a thirty-two point wind-rose (Figure 3) from the Cook Islands, drawn in the nineteenth-century by a missionary, William Wyatt Gill (Lewis 1972). As elsewhere, the names of compass points coincide with those for the winds that blow from those points. Gill reported that the Cook Islanders fashioned a wind device using a gourd into which they drilled small holes. This device was a physical representation of the winds that the chief priest would use to solicit Raka, the god of winds, when the winds were unfavorable and an expedition was planned. Lewis (1972:58) speculates that the

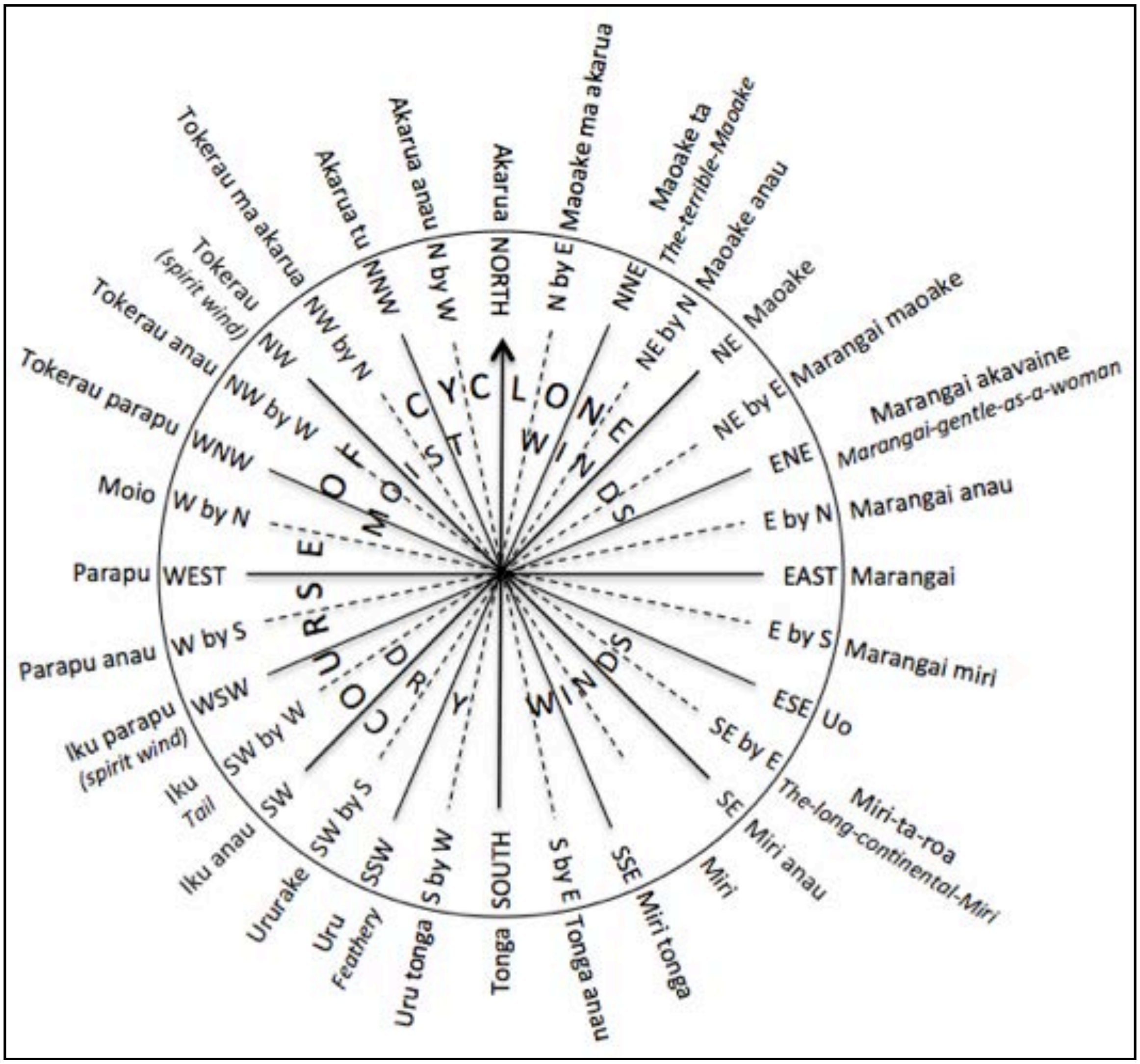

Figure 3. Cook Islands Wind Compass (adapted from Lewis 1994[1972]:113).

Cook Islanders may have used their wind-roses primarily for conceptualizing directions but ultimately relied on celestial referents to set their course for steering.[3]

In the 1930s, Beaglehole and Beaglehole (1971[1938]:21-22) conducted ethnographic research on Pukapuka and drew a wind compass (Figure 4) in which the winds were associated with villages, so that each village was perceived to "control" certain winds. Wind names were reportedly used in village chants, and there was an apparent association between the winds and specific gods who controlled them. The Beagleholes described canoe and sail construction but did not discuss navigation or how the wind compass was actually used.

Accounts of Tahitian navigators by explorers such as Captain Cook and Joseph Banks indicate that, while they were acquainted with the stars, their only compass-like construct (Figure 5) was based on the wind (Finney 2007). Handy (1932) brought the drawing of this wind compass to the Western world but offered no commentary on how

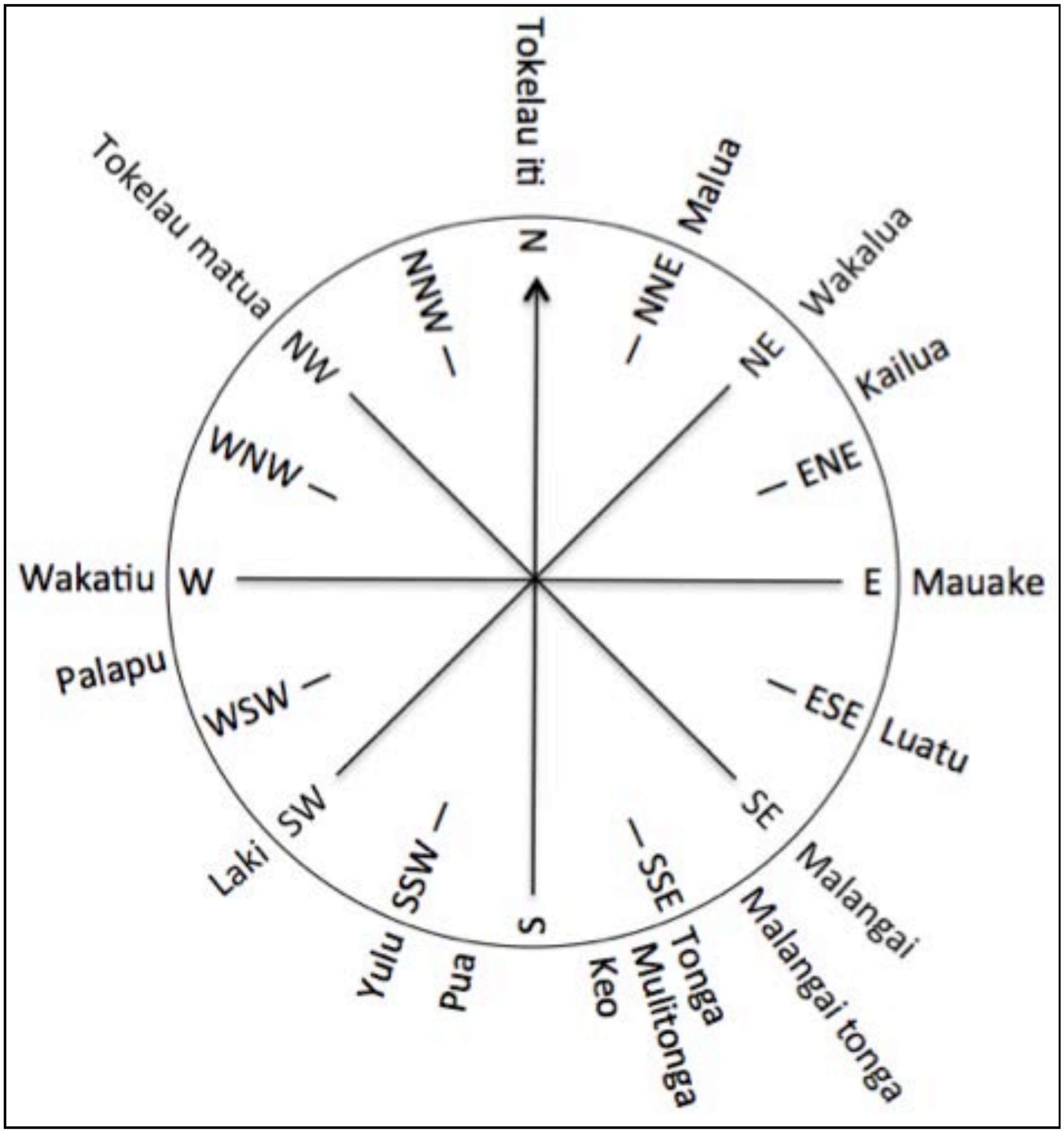

Figure 4. Pukapukan Wind Compass (adapted from Lewis 1994[1972]:114).

his interlocutors used it. Andía y Varela reported in the late eighteenth century that Tahitians divided the horizon into sixteen points, with the cardinal points to the east (sunrise) and west (sunset) (Finney 2007). The names of all the points are also wind names, and many of these names are remembered by Tahitians today. Andía y Varela's account, based on comments by a Tuamotuan named Puhoro, differs from Handy's: Puhoro claimed that there were sixteen points while Handy's wind compass shows twenty-three. However, Puhoro was not from Tahiti, so his description must be treated with caution. Also, the century and a half between Andía y Varela's and Handy's reports could account for some change to the system. Alternatively, Dodd (1972) speculates that the difference can be attributed to Handy's superior ethnographic skills, which elicited more detail.

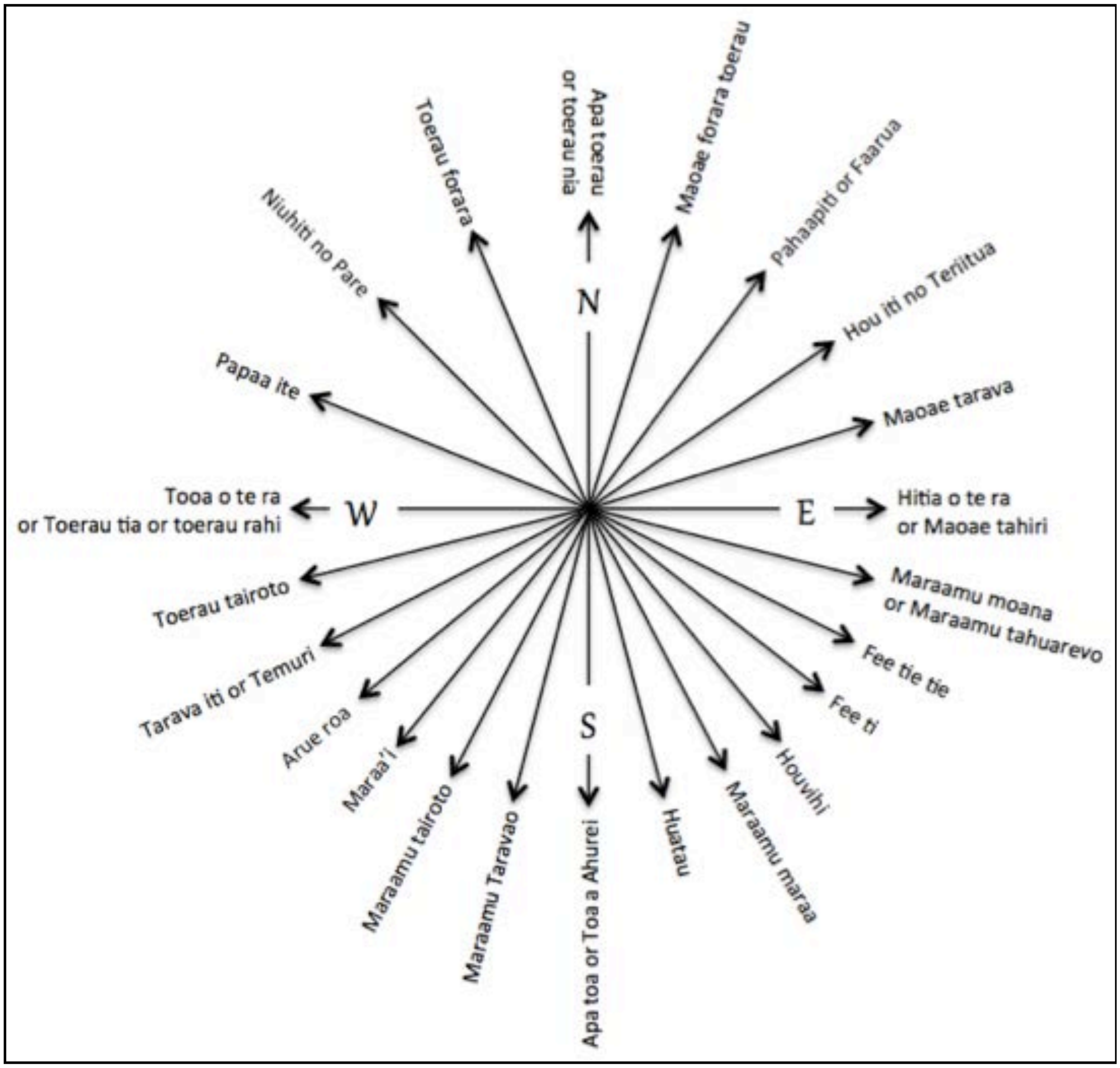

Figure 5: Tahitian Wind Compass (adapted from Finney 2007:162)..

Burrows (1923) reported on what appears to be the existence of a twelve-point wind compass in Tokelau, but he provided scant detail. As elsewhere, each point shares its name with an associated wind. Matagi Tokelau (1991:15), a collection of oral traditions compiled by community elders, presents a 16-point wind compass (*te matāmatagi*). Feinberg and Pyrek's informants, during a two-month field study in 2012, offered variations on the Matagi Tokelau rendition. The differences, however, were rarely glaring.

Lewis (1978:76) reminds us that "the wind being so changeable, its direction must be checked occasionally by stars or sun and it is advisable that the characteristics of different winds be known." He then describes such characteristics of known winds in Tonga. He says that the northwestern wind is warm and full of moisture, the southwestern wind is clear and cold, and southeast trades contain an unmistakable series of cloud formations.

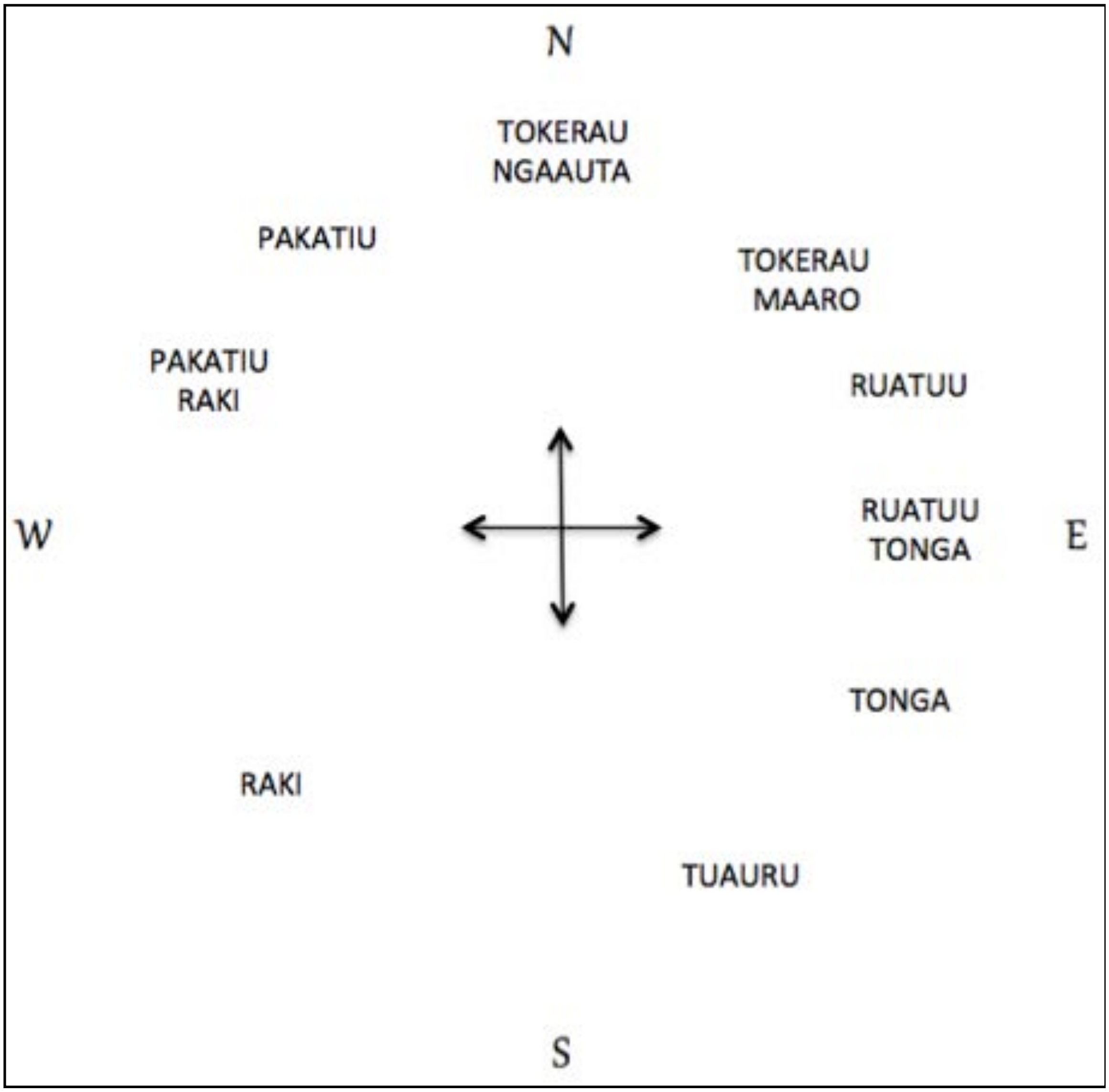

Figure 6: Anutan Wind Compass, as reported by Pu Nukumanaia (adapted from Feinberg 1988:99).

It is from this sort of intimate understanding of the characteristics of the wind that Tongans and their Polynesian neighbors were able to construct and utilize wind compasses.

In addition to the stars and waves, Anutan navigators utilize what Feinberg (1988:92) refers to as a “rudimentary wind compass” (Figure 6). Like others, it indicates the prevailing winds that occur during different times of the year and uses the same names for the winds and the geographical bearings from which they blow. Feinberg’s (1988) research led him to discover much variation in different people’s understandings of the wind compass. His informants identified the winds in the same sequence around the horizon, but the spacing and direction of those winds varied widely. This apparent lack of precision has been noted by other ethnographers such as Lewis and Gladwin, who

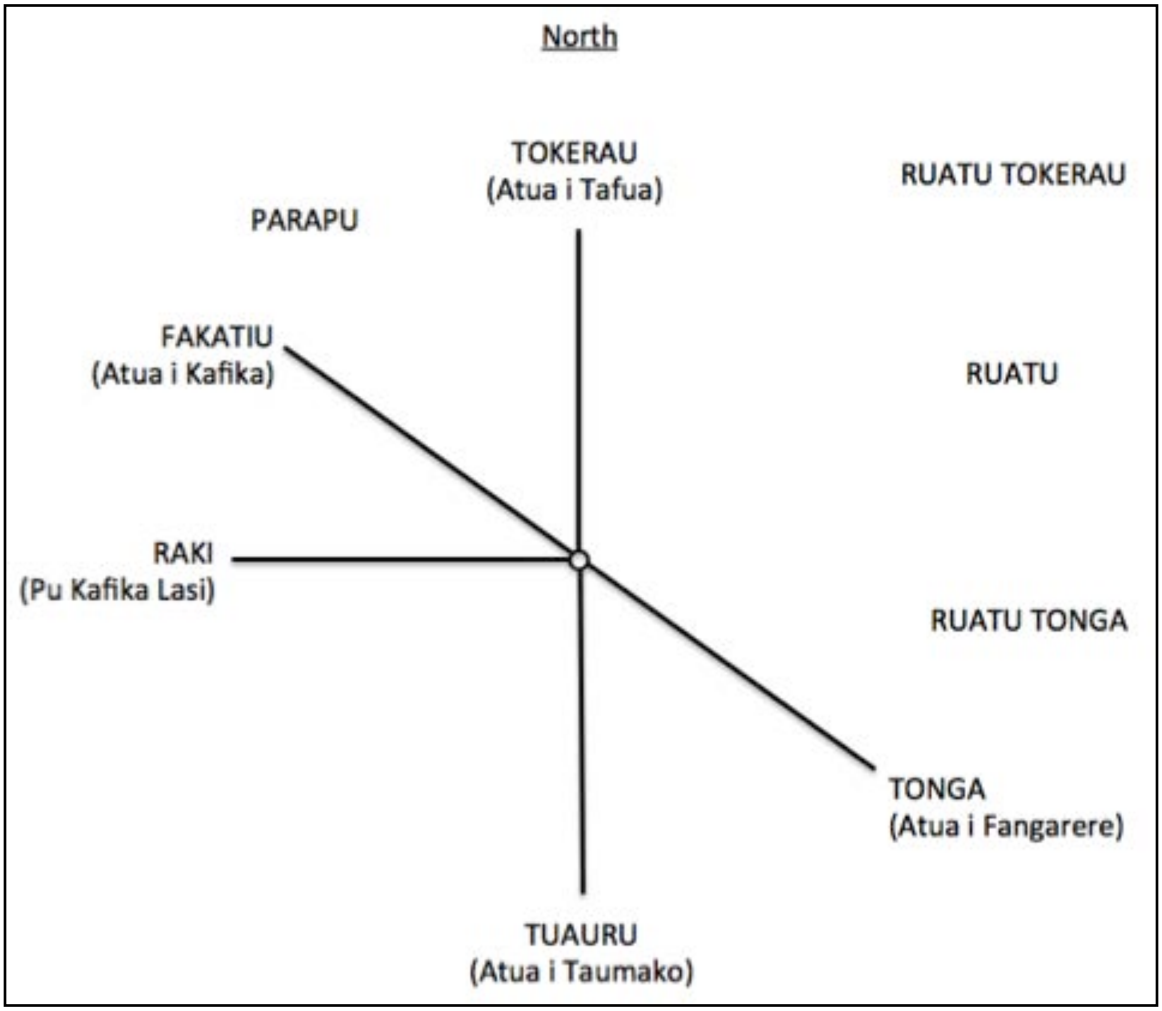

Figure 7: Tikopian Wind Compass (adapted from Firth 1970:156).

observe that such a system must only be good enough to enable the navigator to get where he wants to go, with some margin for error (Feinberg 1988:95).

The winds in pre-Christian Tikopia were associated with the gods. Firth (1970) diagrams Tikopia's wind compass (Figure 7) but says nothing of its use in navigation.

Lewis (1978) notes that Outer Reef Islanders in the eastern Solomons use a wind compass with eight points. These people share the same seafaring tradition as Taumako. Davenport (1964:137-138) does not specifically write of a wind compass, but he does describe the navigators of this region as being especially cognizant of wind patterns.

The Vaeakau-Taumako Navigational "Toolkit"

The paucity of published data might cause doubts about the salience of wind compasses as navigational tools. But that conclusion is belied by comments from Vaeakau-Taumako voyagers. Winds, however, are entwined with multiple additional environmental features: waves, stars, sun, seasons, birds, and a phenomenon known as *te lapa*. Pyrek (2011) has characterized this array of phenomena as a navigational toolkit, which we represent in an

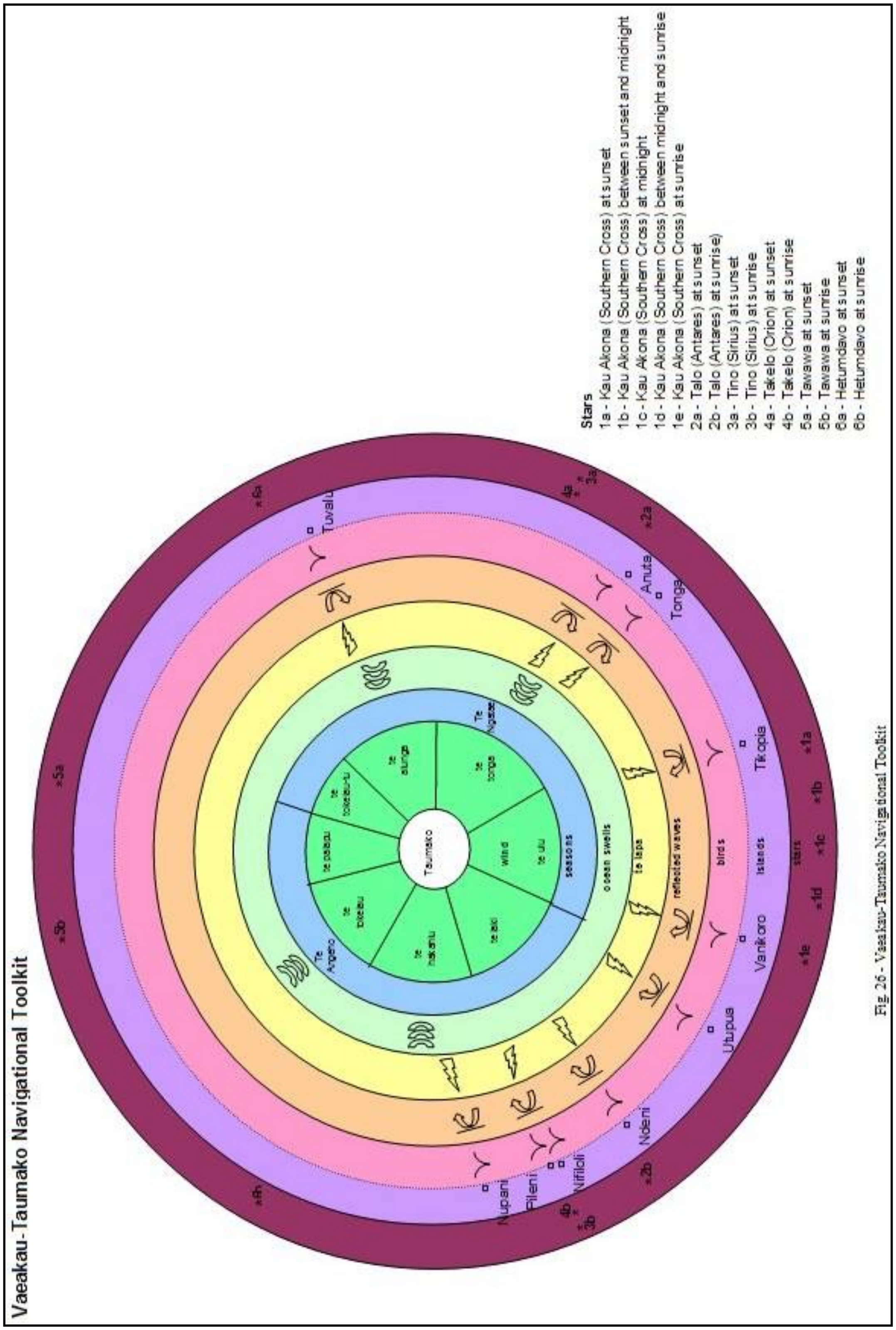

Figure 8: Vaeakau-Taumako Navigational Toolkit.

inclusive diagram (Figure 8). This toolkit portrays the multiple tools available to a navigator, and it should be noted that no one tool is used in isolation; the various phenomena paint a composite picture that an experienced navigator can interpret to find his way.

As is true of Western navigators, Vaeakau-Taumako way-finders approach their trade with practiced consistency. But their approach differs in some respects from that of Western mariners. When a journey fails to go as planned, they deal with obstacles by often-unarticulated intuition (Feinberg and Genz 2012), relying on memories of past experiences, tales told by other navigators, and a general sense of how various local phenomena can be trusted to guide them to safe harbor. As in other Pacific communities (Genz this issue; Lauer and Aswani 2009; Feinberg and Genz 2012), they combine cognitive, visual, auditory, and proprioceptive ways of knowing into an integrated assemblage. Pyrek, a Western-trained sailor, was taught to rely on formulaic approaches to learning such methods. By contrast, Vaeakau-Taumako navigators have developed an intuitive feel for the sea, based on experience.

Vaeakau-Taumako navigation is not "systematic" in the Western sense. If it were, one might expect a high level of consistency in accounts of the salient phenomena and how they are utilized. In fact, responses given by different people can vary a good deal, and even the same person may appear inconsistent from one day to the next (Feinberg, this issue, Boerger n.d., and Feinberg and Genz 2012). Moreover, the means by which navigators have traditionally been taught to navigate and the means by which ethnographers seek to understand that body of knowledge are vastly different. To learn by doing is at considerable variance from learning through book learning and classroom study. What at first seems unsystematic may, in fact, be a system that Western scholarship has difficulty grasping.

The Vaeakau-Taumako navigational toolkit consists of seven elements. Each is represented in Figure 8 and will be discussed in turn. The use of this graphic representation is stylistic only and is not related to concepts of radiality or concentric models of space (c.f. Bennardo 2002; Bennardo 2009; Feinberg 2008, 2014). The importance of each element varies from person to person and from situation to situation. They are, therefore, not presented in any order of importance. They are, however, presented in order of relatedness and proximity. The diagram shows Taumako at its center. The various navigational tools are depicted as emanating from the center in concentric circles.

Wind[4]

Wind directions as depicted by Feinberg's interlocutors (see Feinberg, this issue: Figure 1), resemble what Lehman and Herdrich (2002:184) call a "point field" model, consisting of:

> … a point with a series of vectors … radiating outward.... The field extends out indefinitely and 'boundaries' within such a system are not axiomatic but are derived as relationships between points. *The 'space between' points is always in contention and is therefore a focus of attention* (Lehman and Herdrich 2002:184, emphasis in original).

Although Vaeakau-Taumako conceptions of space generally conform to the more common "container" model (Feinberg 2014; Lehman and Herdrich 2002), the point field model is particularly relevant to wind as it applies to navigation. The Vaeakau-Taumako wind compass has eight primary wind points with both the points and the spaces between them referenced by name; but the boundaries which separate these spaces (e.g., where *te tonga* becomes *te alunga*, or even *te alunga-tonga*) are a judgment call. The vagueness of these boundaries is precisely the source of the ever-shifting 'space between' the points.

One might ask whether geographical directions are named for the winds that blow from them or the winds named for the points from which they blow. The answer is: both. Islanders know the direction of prevailing winds at particular times of year, the directions from which aberrant winds are most likely to come, and the winds that are most useful or most obstructive for their voyaging plans. And they have given names for those directions from which particularly important winds tend to blow. At the same time, they name particular winds on particular occasions for the geographic point from which it is blowing. Partly for that reason we find what seems to be a certain terminological fuzziness, so that when Feinberg pointed out to an interlocutor that he had identified, say, *te palapu*, as being in different directions (according to his magnetic compass) in different parts of the Solomons, the answer often was, "Well, the winds are different here." As Firth once noted (Feinberg 1988:94) with respect to Tikopia, "Tonga, tokerau, etc., are wind points, and as winds back and veer, so the directional indicator changes in Western compass terms…. Like you, I got compass identifications of some variation for each of the major terms…."

Use of the term 'wind compass' is somewhat misleading, as it may imply that people can identify precise points on the horizon without benefit of any reference point. Star and magnetic compasses both have stable reference points. But unless one is able to establish a fixed point on land or in the sky, one must be less exact in identifying wind directions. Since the objective of the wind compass would be to assist in navigation on the open sea under a variety of conditions, such a reference would be problematic.

For this reason, we propose the expression, 'wind circle.' In the Vaeakau-Taumako language, this construct is termed *te nohoanga te matangi,* which literally means 'the seat (or dwelling place) of the wind.' 'Wind circle,' rather than implying a false precision, allows for a range from which particular winds may blow, corresponding to the ranges given by Feinberg's informants. For instance, the wind *te tonga* was identified (usually by pointing) in the following ways:

- Magnetic east, about midway between *te alunga* and *te tonga* (Crusoe Kaveia).
- 120 degrees, east-southeast (Joseph Laki).
- Southeast (Clement Teniau, as described on several occasions).
- South-southeast (Shadrack Tuinamo and Roy Voia).
- 140 degrees, just south of southeast (Peter Taea).
- Southeast, about 150 or 160 degrees (Walter Latao Poniei).

- Sailing from Taumako to Nifiloli (approximately a west-southwest heading), if the wind is *i te tonga*, it is directly off the port beam, placing it at about south-southeast (Crusoe Kaveia).

The Taumako identify specific winds in terms of the direction from which they blow. For example, they might say, "*Te matangi e noho i te tonga*" 'The wind dwells in the *tonga*.' The inclusion of a preposition places the wind in a spatial context. *Te tonga* is arguably the most important wind, allowing for smooth passage from Taumako to Vaeakau, a common journey for the Taumako. According to most interlocutors, this wind takes up the largest range on the wind circle—in some accounts as much as seventy degrees. *Te tonga* is mentioned more frequently than any of the others because it is the predominant wind during the trade-wind season (*te ngatae*), and the winds during this season are more stable than during the cyclone season.

Although the above list describing the direction for *te tonga* covers a range, of the eight wind directions, *te tonga* is the most consistent. In fact, throughout Temotu Province, the direction for *te tonga* is remarkably consistent. Boerger's (n.d.) review of wind direction vocabulary for seven languages of Temotu Province and the corresponding directions from which those winds blow, shows broad agreement with regard to *te tonga*. The other directions show considerable variability.

Winds tend to blow from particular ranges along the horizon during particular seasons, so that the two concepts are inseparable. Feinberg's informants repeatedly referred to the best and worst times to sail to and from particular destinations with emphasis on the season, the winds associated with that season, and their usefulness to a sailing vessel. For instance, Kaveia reported that during the trade-wind season, the wind comes mainly from the *tonga*, and this is when most sailing is done from Taumako to Vaeakau.

The relationship of winds and seasons, and how they impact sailing, is related to Taumako canoe design. Taumako's traditional sailing vessels (termed *te puke* and *te alo* lili) are outrigger canoes constructed from local trees. They are designed to maximize seaworthiness, comfort, maneuverability, and stowage capacity. The partially submarine hulls are hollowed out and covered over. Sails can roughly be characterized as having a "crab-claw" shape and are plaited from pandanus leaves. Some informants felt that this shape performs best with the wind astern because the mast comes in between the two points of the sail, distributing the wind's force symmetrically. Others contended that it performs best on a reach, opining that if running before a strong tail wind, the bow will tend to plow the water. Clement Teniau, a respected navigator from the Vaeakau island of Nukapu, asserted that local voyaging canoes could sail with the wind as close as about 30 degrees off the bow. However, tacking into a direct headwind, or even sailing very close-hauled, is hard work and takes a long time, so people rarely do it. Therefore, being attuned to the seasons and the prevailing winds during those seasons, and knowing where destination islands are in relation to those winds is key to managing a safe, comfortable voyage.

Vaeakau-Taumako navigators use compound terms to identify ranges between specific points on the wind compass (e.g., *te alunga-tonga)*. However, because the eight main points are placed differently on the wind circle, those compound terms would cover ranges that are not exactly the same. They are used the way a Westerner might use the term "north-northeast." Technically, that would be 22.5º on the magnetic compass, but we are unlikely to demand such precision. Similarly, Kaveia told Feinberg that to sail from Vaeakau to Taumako, one sails during the cyclone season, and the best wind is *te tokelau-hakahiu*; however, anything from *te tokelau* to *te laki* is acceptable. Kaveia indicated the bearings of particular winds remain constant regardless of the voyager's position, although the directions to various islands change as one moves from place to place. If one is on Taumako, Tikopia is more or less toward *te tonga*; if one is on Anuta, Tikopia is toward *te laki*.

Seasons

Vaeakau and Taumako recognize two seasons: *te ngatae* is the 'trade-wind season'; *te angeho* the 'monsoon' or 'cyclone season.' Wind and ocean swells, two distinct elements of the navigational toolkit, are connected to the seasons. Timing varies somewhat from one interlocutor to another. According to Kaveia, the seasons are of the same duration: *te ngatae* from late June to late December; *te angeho* from December to June. By contrast, navigator Teniau reported that the *ngatae* lasts from April to late December. The rest of the year is the *angeho*. Both of these experienced mariners agree that the best voyaging times are from March through December—with the caveat that July and August are best avoided because trade winds blow too hard.

In our diagram, each season corresponds to one hemisphere of the circle and four associated wind directions. Although winds may come from anywhere at any time, during *te ngatae* they blow predominantly from the east or southeast, and during *te angeho* they blow predominantly from the northeast through the northwest.

Taumako sailing canoes are able to beat unusually well into a headwind. George's report that "one such vessel … could point higher and go faster than her 10-meter-long gaff cutter rig" (Feinberg and George 2012:82) is supported by wind tunnel experiments involving a variety of Pacific sail designs (Di Piazza et al. 2014). Nonetheless, tacking against the wind is hard work and time consuming, and Vaeakau-Taumako sailors try to avoid having to do so. Knowledge of the prevailing wind patterns allows voyagers to take advantage of the changing wind both for their outward journeys and when it comes time for them to return home. Consequently, a round trip can take several months.

In addition to affecting the relative ease of arriving at one's destination, winds influence another crucial navigational signpost: ocean waves. Wind blowing persistently in the same direction causes the water to "pile up," and these piled-up waves are what Vaeakau-Taumako navigators know as *hokohua loa* 'swells.' *Te hokohua loa te ngatae* and *te hokohua loa te angeho* are both detectable throughout the year, but their relative strength varies with the season. *Te ngatae* and *te angeho* identify the two seasons and the directions from which the prevailing winds emanate during those seasons. Thus, a wind from *te tonga* is a *ngatae* wind, and a wind from t*e laki* or *te tokelau* is an *angeho* wind. Finally, the names correspond to the ocean swells that are caused by those prevailing winds.

Stars

Of the natural phenomena observable at sea, the stars are the most stable and reliable. They may not always be visible. When they are, however, a navigator who knows the celestial patterns can be assured of his heading. Yet individual navigators make use of the stars to varying degrees—just as they vary in the degree to which they rely on each of the toolkit's other elements. At one end of the spectrum, Kaveia believed it was necessary to have extensive knowledge of the nighttime sky. On the other, one experienced sailor reported navigating by but a single star. Most fall somewhere between.

Despite awareness of at least nine named asterisms, Kaveia, in his conversations, emphasized two or three primary stars, suggesting that other secondary stars coming before or after were less important—that they were only relevant for a small part of the night or were so obvious as not to require special commentary. Perhaps, he conceptualized the movements of many stars in terms of the movements of just a few.

Taumako navigators use the stars for two purposes. The first is orientation. If a navigator finds himself turned around and disoriented at sea, the absence of landmarks can present a hazard. Other phenomena, such as wind and swells are also used for reorientation. Some navigators, such as Clement Teniau (Feinberg and Genz 2012), are more comfortable using swells than stars because they perceive swells as highly stable and reliable, whereas the stars move around. Yet most navigators find stars to be at least a comfort, knowing that the sky's patterns are eminently trustworthy. Some less experienced sailors consider stars to be the primary navigational tool; yet, even those who prefer the stars for orientation are sometimes forced to use other means when the weather is uncooperative.

The second purpose is to guide navigators to specific destinations. This use of stars, however, is complicated by currents and winds. When sailing with a wind directly astern, one aims toward a star that sets directly over the target island; but if sailing with a wind to port, one would sail toward a star that sets to the left of the island, or aim to the left of the guide star, to account for leeway. Should the winds change, as they are prone to do, adjustments may be needed in the use of stars as guides. Moreover, if one habitually sails to a particular destination at the same time of year and under similar conditions, the relationship of particular stars to one's destination will become familiar. Thus, the navigator will sight stars as they rise and set along the horizon at predictable distances from the destination island. One can aim toward the island knowing that a star should align on a point on the canoe other than the prow.

Our diagram shows stars as the outermost ring, because they are the most distant phenomenon. The stars shown are examples of commonly named stars and their approximate rising or setting points. These rising and setting points vary slightly, and the times at which they rise and set vary significantly, through the year. Many stars are not even visible for much of the year. Because particular destinations are consistently sailed to at approximately the same time of year, these variations are not a hindrance. For example, the Taumako consider the guide star to Nifiloli to be Talo, which does not set directly over Nifiloli, but rather to the left (i.e., south) of it. They regularly travel there at a time of year when the winds are blowing from *te tonga* and push the vessel to the right of the guide star, right on track for their destination.

Swells

Vaeakau-Taumako sailors recognize three kinds of wave (*hokohua*). One of these—chop, or seas—is caused by temporary local winds and is not useful for navigational purposes. Ocean swells, called *hokohua loa* 'long waves,' are waves that traverse great distances and are caused by prevailing winds. The third is reflected waves, waves that have hit an island and bounced back toward the canoe (cf. Genz, this issue).

Swells are caused by seasonal winds. These tend to blow from the east or southeast during the trade-wind season (*te ngatae*) and from the northwest through the northeast during the cyclone or "monsoon" season (*te angeho*). *Te hokohua loa* comes in two varieties: *te hokohua loa te ngatae* and *te hokohua loa te angeho*. In Figure 8, the swells are shown in the circle beyond the seasons because they are so closely associated with the seasons.

The result of this regularity is that while at sea, one can make use of swell patterns to recognize changes in local winds. If the wind does change, that change will be apparent when compared to the more stable swells. This is especially useful when there are no other visible cues, such as the stars. Some navigators even give swells precedence over stars (Feinberg and Genz 2012). The swells can experience subtle changes in direction, but the shift is not abrupt. If one were to experience a change in the swell direction on a lengthy voyage, there would likely be an opportunity to verify the change based on the movement of the sun, moon, or stars.

Te lapa

Te lapa has not been scientifically verified; but it is part of the Vaeakau-Taumako navigational toolkit, and many navigators swear by it. Genz et al. (2009) encountered a similarly vexing phenomenon in Micronesia. A particular wave pattern identified by Marshallese navigators could not be detected with instruments or explained by researchers. Nonetheless, Marshallese navigators were able to use these seemingly non-existent patterns to find their way. The authors were left to conclude that their interlocutors have "alternative ways of conceptualizing the ocean that do not easily fit within a scientific framework" (Genz et al. 2009:220).

Te lapa has been described as "like underwater lightning," appearing as a streak of light in the darkness of the ocean. Some informants (Crusoe Kaveia, Abraham Maone, and Jonas Holland) described the streak as a straight line, more like a flashlight beam than the zigzag of a lightning bolt. It points to land and is used by navigators to identify an island's location. Lewis (1972) used the expression "deep phosphorescence" to describe it and said that it appeared from one to twelve feet below the surface. By contrast, both George (2012) and Feinberg's informants (Feinberg 2011) all agree that it appears at or near the surface.

Islanders vary as to the distance at which they estimate that one can see *te lapa*. However, there are some consistent patterns. It is primarily a homing device, shown in Figure 8 as the first of three homing tools used by the Taumako. It is most useful at roughly thirty to eighty miles away from one's destination. If there are multiple islands within this range, *lapa* interference from other nearby islands can be a problem. Kaveia reported that this is common and that one must know in advance the relative positions of the islands in order to determine which emanation is associated with which potential destination. Once one gets within about twenty miles of one's destination, it is no longer helpful.

Shadrack Tuinamo, from one of the Vaeakau islands, commented that *te lapa* starts small, gets big, then gets small again as one approaches the destination island. In other words, the intensity of *te lapa* is at its peak at a certain distance out from the island, and farther and closer from that distance, the intensity diminishes. Kaveia suggested that the intensity of *te lapa* corresponds to both distance and the size of the island to which it points.

Despite the fairly general agreement that *te lapa* is best observed a few dozen miles from its island of origin, Kaveia reported using it to find his way from Ndeni to Santa Ana, approximately 300 miles away. Many sources note that the usability of *te lapa* varies with sea conditions. Some say that dark and stormy seas produce the best conditions for seeing it, while others say dark calm seas are best.

Reflected Waves

Like *te lapa*, reflected waves are used for homing in on an island; but their range is smaller, with a maximum of twenty to thirty miles. These waves are weaker and harder to detect than swells. The closer one gets to an island, the bigger they will be; but they are never very strong. One must have a mental picture of what landforms make up potential "reflectors" or risk arriving at the wrong destination. Some Vaeakau-Taumako people call reflected waves *hokohua ttuki* (or *hokohua ssuki*) an expression that refers to the way these waves 'bang' into the hull of a vessel, *ttuki* being one term for a banging motion. Others call them *hokohua te kaenga* 'waves of the place.' Vaeakau people tend to use the expression, *hokohua potopoto* (sometimes pronounced *hokohua poroporo*), literally 'short waves.' Figure 8 shows them as the second homing tool, just beyond *te lapa*.

Birds

Birds are shown in Figure 8 as the last circle of homing tools, just beyond reflected waves. They are useful to the navigator who has sailed within their feeding range but cannot yet see the island. In order to make use of this indicator, one must be adept at recognizing what particular birds look like, how they sound, and what their feeding patterns are. The navigator must be able to distinguish whether the birds are flying out to feed, flying back to the island to nest, or simply flying around looking for food. It is also useful to know what the typical feeding range is for various birds. A navigator who sails to a point where birds should be feeding and finds none, knows that something is amiss.

Crusoe Kaveia and Jonas Holland identified a number of birds that can be used to indicate land at different times of day, with the most useful times generally being at dawn and sunset. Birds typically mentioned by navigators include *te tavake* 'tropic bird,' *te kotaha* 'frigate bird,' *te kovaa* 'heron,' *te mounga*, and *te ngongo*. Kaveia recalled a particular journey when he was a young man traveling from Taumako to Pileni. He remembered the winds, the waves, *te lapa*, and the birds. He remembered that before dawn, he could hear the calls of the *tavake* and could follow the sound. The birds, *te mounga* and *te ngongo*, were seen at dawn and led the way to shore. When he later returned to Taumako, the same birds were used to guide him home.

How to Use the Vaeakau-Taumako Navigational Toolkit

How do Taumako sailors use the toolkit as represented in the diagram? It is important to establish a few basics about how the wind impacts propulsion on a sailing vessel.

On a modern Western sailboat, one can sail about a 270º circumference of the horizon. In other words, if the wind were coming from the north, one would be able to sail at any heading from northeast to south, all the way around the compass to northwest. But there is a dead zone from the northwest to the north and northeast, where it is not possible to sail because it is directly into the wind. If the destination is in this direction, one can still get there, but it is going to take longer because it requires zigzagging, or tacking. In order to tack back and forth on this kind of boat, one turns the rudder and lets the sail(s) flop to the other side, a maneuver known as coming about.

With a traditional Taumako sailing vessel, the tacking strategy is different. These vessels are designed to keep the outrigger toward the wind. When they tack, the bow (that is, the front of the boat) becomes the stern (i.e., the back) and vice versa. That means that the sail has to be removed, folded so it doesn't catch the wind, moved to the other end, replaced, and unfurled. Experienced sailors have learned to do this quite efficiently; still, it is more complicated than tacking on a European sailboat. In part for this reason, sailors of traditional Taumako vessels try to minimize the need to tack.

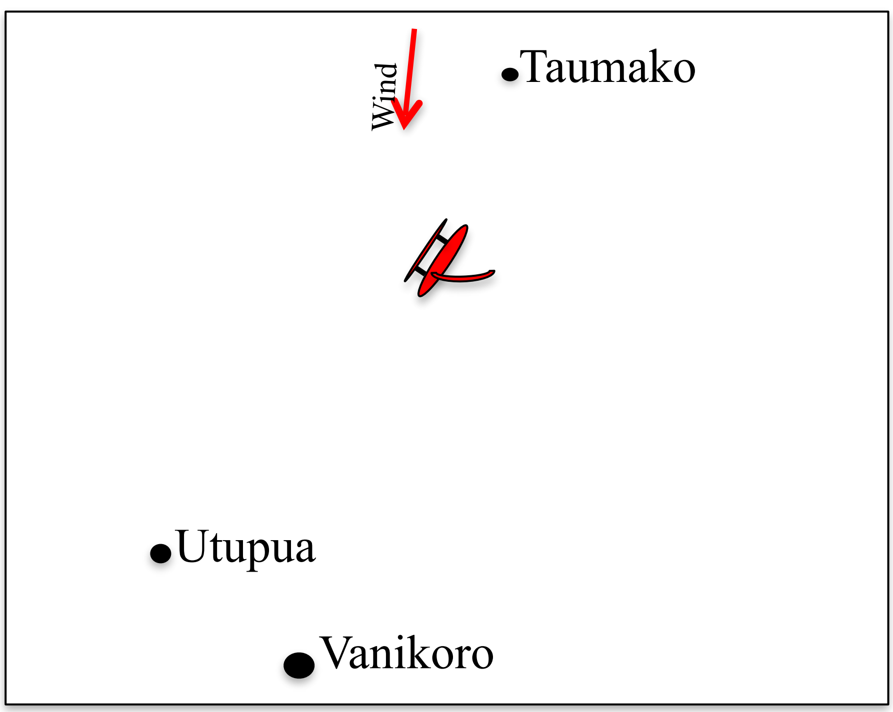

Figure 9: Example Sail from Taumako to Utupua or Vanikoro.

The result of these realities is that there is an identifiable sweet spot for the wind in relation to the canoe. It is a wide, forgiving sweet spot, but it is aft of abeam; thus, voyagers prefer to sail downwind. Winds blow from certain directions at certain times of year. Therefore, if you want to go west, chances are you are going to go during the trade-wind season.

Nothing in the toolkit is used in isolation. Rather, it provides a fluid framework that offers multiple options for a multiplicity of situations. It can be thought of as a guide for considering the variety of tools available. Here we offer a few examples from interviews with Chief Kaveia of how the pieces are combined:

- During the *ngatae* season the wind generally comes from *te tonga*, and the most important navigational constellations are Salo (Talo 'Antares'), Sino (Tino 'Sirius'), and Takelo 'Orion's Belt.'[5]

- If sailing from Taumako to either Utupua or Vanikoro, one should go during the *angeho* season and follow Te Kau Akona (the Southern Cross) (Figure 9). The wind should be from *te palapu* or *te tokelau-palapu*. The Southern Cross sets between Utupua and Vanikoro—somewhat west of south. The outrigger, as always, is kept to windward. If the wind is coming from *te tokelau* or *tokelau-palapu*, the outrigger is to starboard. When going to Utupua, point the bow to the west of the Cross. If the wind is coming from *te palapu*, the outrigger is to port and the bow is again pointed to the right (west) of the Cross. But when going to Vanikoro, point the bow to the east of the Cross.

- To sail from Vaeakau to Taumako, travel during the *angeho* season. Follow the stars Takelo and Sino. The best wind is *te tokelau-hakahiu*, but anything from *te tokelau* to *te laki* is acceptable.

- Sailing from Taumako to Vaeakau, the heading should be west-southwest. September to October (during the *ngatae* season) is the ideal sailing time. This is because the wind is relatively stable, but not too strong; and it comes from *te tonga*, which means running before a tail wind, slightly off to port. The most important navigational constellations are Salo, Sino, and Takelo. Salo is the guide star to Nifiloli, although it sets to the left (south) of Nifiloli. With a tailwind slightly off to port, the canoe will be pushed toward its destination.

- Kaveia described sailing to Tikopia and Anuta. These are not places to which Taumako people normally voyaged, so his comments were based on decades of conversation with people who had been to those islands as well as his broad knowledge of the sea. His description, therefore, was hypothetical, which helps to illustrate how the toolkit can be utilized to make passage even to a place where a navigator has no direct experience sailing. He said that, sailing to either Anuta or Tikopia, one would travel during the *angeho* season. For Tikopia, the best winds are *te palapu*, *tokelau-palapu*, or *tokelau*. The guide star is Sino, which Kaveia said has its zenith directly over Tikopia. For Anuta,

> the season and winds are the same, but the stars are different, with Hetumdavō 'Pleiades' or Hakangi 'Orion's Shoulders' as guide stars.

Other experienced sailors told comparable tales. Abraham Maone, about eighty years of age, considers himself a capable navigator. When he sailed as a young man, he relied on a range of tools including stars, winds, swells, reflected waves, and *te lapa*. He does not see any one of these as more important than another but described them in Pijin as "sem-sem" 'equivalent.' If one were not available, he would look for others. If unable to see the stars, he would attend to the wind. If the wind changed, he could tell by keeping track of the swells (*hokohua loa*). Upon approaching an island, he would become aware of its presence by the reflected waves (*hokohua ssuki*). *Te lapa* was also important when approaching an island but, of course, only at night.

According to Teniau, a voyage from Vaeakau to Taumako normally takes place during a three-month period between December and March (i.e., during *te angeho*). Any time during that period is acceptable, as long as one is careful about the weather.[6] Kaveia identified the best wind as *te hakahiu-tokelau*, putting the wind astern and slightly to port, but he also said that any wind from *te tokelau* to *te laki* is acceptable. The guide stars, regardless of wind, are Takelo and Sino. In all instances, as one closes in on the destination, *te lapa*, reflected waves, and finally birds, will assist the navigator in locating land. Each tool has its strengths, but the true strength of the Vaeakau-Taumako Navigational Toolkit is found in the array of tools available to inform the navigator during myriad circumstances.

Comparison of Wind, Star, and Magnetic Compasses

Magnetic, star, and wind compasses are all based on naturally-occurring phenomena: the magnetic force at the poles, recurring star patterns, and the regular wind patterns of the tropical Pacific. The magnetic compass differs significantly from star and wind compasses in that it is a physical device which responds to the earth's magnetic pull. The others need not be physically represented in order to be useful, and neither responds to corresponding phenomena the way that a magnetic compass responds to magnetic north. Rather, stars are readily seen by the eye, and the wind is felt by the skin—as well as "seen" via streamers, seas, and spray. Star and wind compasses can be physically represented on paper, but for the people who use them, the salient structure lives in their heads. These are mental constructs designed to provide an understanding of a particular domain of knowledge: navigation. Each type of compass is well-suited to the purpose for which it was designed. Navigators who depend on any one of them are generally successful. Each type is used in a particular environment, each with its distinctive resources and limitations.

The magnetic compass has the advantage that it is not susceptible to change: with minor variation owing to a discrepancy between the magnetic and celestial poles, north is consistently in the same place. This is helpful when at sea without any differentiation in the sky or on the water. Moreover, it can be used in any weather, day or night, although it does require a light source on a dark night.

The star compass is likewise not susceptible to change if one stays close to the equator. Even away from the equator, the shift in position of the stars is regular and predictable. However, the stars become less useful to a navigator as they rise far above the horizon or drop out of sight. This is especially true as one moves away from the equator, because the stars appear to make an arcing motion across the sky. In addition, there is the inconvenience that stars are visible only at night. The sun is visible in the day but, especially when close to the equator, it is only useful as a pointer toward east or west near sunrise and sunset. The moon poses similar constraints and is occasionally not visible at all. And clouds can be an obstacle to making any use of celestial bodies. For this reason, knowledge of weather patterns can be critical.

A wind compass is the least stable of the three in that winds shift and, at sea, there may be no reference point to monitor shifts in wind direction. That liability, however, does not disqualify it as a source of information. While there may indeed be no visual reference point by which to gauge a shifting wind, there are palpable reference points. Winds from particular directions have particular properties. To the untrained, these differentiations mostly go unnoticed. But for those who rely on the wind, a directional shift is accompanied by other changes. When the wind shifts direction, its "flavor" alters as well. While these shifts are often detectable, their detection is not instantaneous and precise. For this reason, the wind's relationship to other phenomena can be important, and most Pacific navigators are attuned to many different information sources.

In the current era, people who have never seen the sea may be aware of modern navigational devices that offer extraordinary precision. Standard-issue global positioning systems (GPS) are readily available. These devices can be accurate enough that one could start from anywhere in the world and sail directly to a position the size of a basketball. No compass can direct a navigator with that degree of accuracy. But rarely is such precision necessary when sailing toward a destination the size of an island. Moreover, a GPS is often impractical in remote areas where the ability to maintain high-tech units and keep them supplied with batteries is difficult. Further, unlike a star or wind compass, a GPS device or magnetic compass can be dropped overboard. The greatest disadvantage of star and wind compasses is the extensive training and practice required to make effective use of them. Magnetic compasses and GPS devices require comparatively little learning.

Cognitive Similarities and Differences

"Undeniably, a great deal of order exists in the natural world we experience. However, much of the order we perceive in the world is there only because we put it there" (Holland and Quinn 1987:3). The cognitive constructs that have been developed to assist navigators in their way-finding activities exist because someone sought to order natural phenomena in such a way as to be able to manipulate them mentally to facilitate the decision-making necessary for competent interaction with the world. These models are all abstractions, different from each other, yet similar in critical ways, and with the same general purpose.

Cognitively, there is an obvious similarity between magnetic, star, and wind compasses—as the fact that English speakers refer to each of them as a "compass" attests.

Each is a circular depiction of the earth's surface, with the observer in the center and the horizon around the circumference. Each indicates regular (although not necessarily equidistant) points along the horizon. It is common for there to be 32 points on a compass. Frake explains this as the natural outcome of dividing a circle in equal halves sixteen times. Dividing the circle in half once, twice, four, or eight times also gives an equally divided circle, but lacks the specificity that 32 points offers. To split the 32 points again and create 64 points would likely be overkill. Perhaps more critically, when an average-sized man holds his fist out at arm's length, the width of his fist is about eleven degrees. The math works out to 32 points on the horizon that are about a fist's width apart (Frake 1995:156). This makes a handy reference point.

Having 32 points is common, but not universal. The number of reference points on a navigational compass corresponds to the number of reference points that those who use it find necessary. That variation is attributable to a number of factors: distances typically traveled, number of destinations regularly visited, and factors that may help or hinder the navigational process (such as visible landforms or the use of multiple devices).

In addition to the 32 points, many compasses differentiate cardinal, secondary, and tertiary directions. The extent to which a compass utilizes compound terms to identify reference points is related to the extent to which those who use it find such differentiation necessary. If fewer reference points are required, all three levels may not be considered.

One way in which stars and the wind differ as the basis for cognitive constructs springs from the fact that the wind typically blows from only one place at a time.[7] By contrast, stars are numerous and are often grouped together in clusters to form recognizable patterns. In fact, there is a parallel between the indistinctiveness of individual stars and what the untrained person might perceive of wind. One star looks more or less like any other of the same magnitude. A wind from one direction may feel like one from any other. However, when a star is combined with others and made to paint a picture, it becomes recognizable to a careful observer. Likewise a wind can be understood in the context of the seasons and the swells, informing the navigator and providing the orientation needed to set a course.

Concluding Thoughts

A compass, whether star, wind, or magnetic, is limited in its effectiveness because one tool cannot do everything. However, no competent navigator sets out on a voyage with only one trick in his bag. Rather, one draws from many information sources, each of which is more or less useful depending on the environment. A navigator sailing on a dark night without a flashlight or a match will find a magnetic compass much less useful than the stars. If clouds obscure the sky, orientation by celestial bodies will be problematic. When the wind dies, it does not matter to a sailing vessel what device is used for way-finding. However, when the wind begins to blow again, the navigator must know where he is and how to proceed. In short, selection of an appropriate way-finding technique does not depend on viability per se. All are viable. The choice depends on the tool's suitability for the task at hand.

The diversity of navigational environments has given rise to a variety of way-finding techniques. It is no coincidence that the magnetic compass took root among Europeans, who have combined it with Mercator projections and celestial navigation to sail large swaths of the earth's open oceans, most often well off the equator. To rely exclusively on skies or winds as navigational templates would be challenging under these circumstances. For a vessel spanning the globe, a magnetic compass offers more accurate navigation than the star or wind compass.[8]

Some way-finding techniques are probably common to all seafarers, some are common to most, and some are known only to a few. And the ones employed by just a few are used to varying degrees depending on local conditions. The more the construct conforms to those conditions, the more it is employed. Vaeakau-Taumako navigators depend on an elaborate "toolkit," and the wind compass is one critical part of that package. As elsewhere in Polynesia, wind names correspond to directional names. Polynesian wind compasses differ in the amount of detail they contain, the winds' reliability, and the correlation of winds with other natural phenomena, including the extent to which those phenomena are used to confirm wind direction.

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1 We frame this discussion in terms of cognitive (rather than more broadly "cultural") constructs to differentiate the understandings shared by Vaeakau-Taumako navigators from the experience other members of the population. Constructs designed for inter-island navigation are narrowly understood by only a few individuals and not society at large. They are intentionally taught and make use of perception, conception, and responsive behavior. Decision-making and subjective experience are at play, making the wind compass and accompanying toolkit mental models of the natural world, i.e., cognitive constructs.

2 We follow Ammarell (1999) in using the term, "asterism," to cover culturally relevant celestial phenomena, including both individual stars and constellations.

3 However, Marianne George, who sailed around the world with David Lewis, has suggested (personal communication) that Lewis emphasized islanders' reliance on celestial bodies rather than the wind in deference to the proclivities of his scientific audience, which he believed would be more inclined to accept them as a reliable way-finding tool. Furthermore, some navigators from the Vaeakau-Taumako region (see, e.g., Feinberg and Genz 2012:34) report they rely primarily on waves and winds, while stars to them are, at best, secondary.

4 George (2012; Vaka Taumako Project 2011) has offered detailed representations of Taumako's wind compass. Feinberg's informants conveyed to him a less precise and symmetrical understanding of the system. However, we agree with George that the wind compass is intimately connected to a variety of other navigationally salient phenomena, including wave patterns and the movements of celestial bodies.

5 Terms in parentheses are alternate pronunciations. The usual Polynesian term, for example, is Talo or Taro, but Taumako speakers often change an initial /t/ to an /s/.

6 Kaveia disagreed and said that February is not a good month for sailing anywhere; Teniau acknowledges that February is problematic, but sails with caution. This discrepancy can be accounted for by noting that Kaveia's sailing range was typically significantly greater than Teniau's, causing him to be at sea much longer and allowing more time for the weather to change.

7 There are, of course, exceptions such as swirling winds that occur during cyclonic storms. Competent navigators, however, do their best not to be at sea under such conditions. And when they are, they are likely to take down the sail until the storm subsides.

[8] Another critical significant factor in development of the magnetic compass, of course, is access to iron.

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