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"By Small Means": Rethinking the Liahona

Timothy Gervais and John L. Joyce

Abstract: *The Liahona's faith-based functionality and miraculous appearance have often been viewed as incongruous with natural law. This paper attempts to reconcile the Liahona to scientific law by displaying similarities between its apparent mechanisms and ancient navigation instruments called astrolabes. It further suggests the Liahona may have been a wedding dowry Ishmael provided to Lehi's family. The paper displays the integral connection Nephi had to the Liahona's functionality and how this connection more clearly explains the lack of faith displayed by Nephi's band during the journey than traditional conceptions of its faith-based functionality.*

> "Yet I will say with regard to miracles, there is no such thing save to the ignorant — that is, there never was a result wrought out by God or by any of His creatures without there being a cause for it. There may be results, the causes of which we do not see or understand, and what we call miracles are no more than this — they are the results or effects of causes hidden from our understandings ... [I]t is hard to get the people to believe that God is a scientific character, that He lives by science or strict law, that by this He is, and by law He was made what He is; and will remain to all eternity because of His faithful adherence to law. It is a most difficult thing to make the people believe that every art and science and all wisdom comes from Him, and that He is their Author."
> — Brigham Young[1]

The Liahona, a navigational and revelatory instrument described in the Book of Mormon, is perhaps the greatest historical enigma of the ancient account. Its miraculous appearance and ostensibly spiritual operation have often been met with derision by individuals who are critical of the Book of Mormon's historical plausibility. Indeed, as stated in the words of Hugh Nibley, "The Liahona has given rise to endless merriment and mockery among critics of the Book of Mormon; only the shining stones of the Jaredites can equal it as a laugh-getter."[2] Perhaps as a response to these criticisms, a surprising number of authors have attempted to correlate aspects of the Liahona's functionality with known scientific principles.[3] With minor variation, the majority of these previous apologetic works have suggested parallels between the Liahona's navigatory features and geomagnetic navigation devices. While the present work also attempts to reconcile the Liahona's functionality with historical navigation devices, it challenges traditional conceptions of both the Liahona's magnetic and faith-based functionality. Textual and cultural evidence seem to suggest the Liahona may in fact have been a star-based navigation instrument, one similar in function to that of an astrolabe.

A Note on Magnetism

In the interest of establishing the need for the present work, a few critiques about the predominant theory of a geomagnetic Liahona are warranted. A chapter from the book *Re-exploring the Book of Mormon,* entitled "Lodestone and the Liahona," written by Robert F. Smith provides a functional reference to the theory.[4] Smith proposed that the navigational properties of the Liahona may have functioned on "geomagnetic principles," while the revelatory aspects of the device were faith-based and wholly outside the realm of scientific discovery.[5] Smith and other proponents of the theory have thus articulated what might be termed a "hybrid model" wherein the navigatory and revelatory features of the device operated on two disparate principles (i.e., magnetism and faith). While Smith's work and others comparable to it have attempted to scientifically explain the Liahona's *navigatory* features, the theory of a hybrid-model Liahona does little to address historical or scientific critiques of the device, as both its origin and revelatory properties still appear to have operated outside the realm of modern scientific discovery.

Furthermore, a device functioning on geomagnetic principles is a remarkably poor fit for the device and type of journey described in the text itself. Magnetic compasses are valuable only insofar as an individual has a map or comparable knowledge of a region to provide accurate

positional information to couple with directional information derived from a magnetic compass.[6] Whereas Nephi may have been able to receive some sort of cartographic information via revelation, the text seems to suggest such was not the case. When the company begins to follow the Liahona, they seem wholly dependent upon it for directional guidance.[7] When the text does record communication from the Lord directly, the content of the message is almost exclusively chastisement or other information not directly related to navigation.[8] Additionally, the Lord seems careful to direct questions regarding directional information back to the ball.[9] It appears significant that the Lord communicates some types of information through revelatory means while leaving navigational communication to the Liahona. This pattern may suggest that the Liahona was less of a revelatory device and more of a navigational device than is traditionally assumed. Indeed, a careful reading of the text indicates the Liahona was used to communicate only information that can be derived from a naturally functioning astrolabe (e.g., the direction of travel, the location of water,) while other information (how to build a ship, moral chastening, where to find ore, etc.) were communicated via revelatory means.

Astrolabe Technology

To understand the textual parallels between the Liahona and astrolabe technology, one must first understand the basic functionality of ancient astrolabes. Stated simply, an astrolabe is an astronomical instrument capable of providing navigational information using the position of the sun or stars.[10] Functioning as an analog computer, an astrolabe physically models the visible universe by storing information about star placement on the astrolabe itself.[11] By manipulating this static model to match the conditions of the sky at a present location, information about physical location can be derived.

Although celestial navigation was common among ancient peoples long before the astrolabe,[12] the invention and distribution of the astrolabe provided a far more structured approach than previous methods.[13] In essence, the astrolabe standardized and solidified mathematical positional computation into a singular instrument, which later evolved into modern navigational instruments such as the quadrant and the sextant.[14] Although no effort will be made in this work to articulate the exact mathematics that allows an individual to derive locational information from such instruments, it should be understood that astrolabes provide positional information only as the user is able to manipulate and read the device. If the Liahona functioned on similar principles, it would have been subject to

the *operation* of Nephi and Lehi, rather than the party passively following instructions provided by the ball. Several nuances of the Book of Mormon text suggest this model to be a more accurate description of the Liahona than traditional perceptions.

Dating of Astrolabe Technology

The origins of astrolabe technology have been traditionally attributed to Greek astronomers in 200 BCE –100 BCE.[15] However, as no functional astrolabes or expositions on true astrolabe technology have survived from this period, scholars have long recognized that the inference is tenuous and largely conjectural.[16] This traditional dating is largely predicated on what appears to be the emergence of stereographic projection during this time period, a mathematical mapping function whereby a sphere (such as the night sky) is mapped onto a two-dimensional plane.[17] This mathematical innovation is necessary for the production of the most common archaeological form of astrolabe, the planispheric astrolabe, a flat instrument utilized in Europe and the Middle East throughout the Middle Ages. As such, the treatises of Hipparchus of Nicaea (180 BCE – 125 BCE), which articulate the concept of stereographic projection, have often been used as the *terminus post quem* for the dating of astrolabe technology. However, in the words of Robert T. Gunther, the founder of the Museum of Science at Oxford, which currently houses the world's largest collection of astrolabes, there are several "trains of evidence which point to a far earlier date for the invention."[18] Gunther himself suggests that stereographic projection may instead have had its origins in the constellation mapping performed by Eudoxus of Cnidus (409 BCE – 356 BCE).[19]

Figure 1. Planispheric Astrolabe. Image used under Create Commons License; https://commons.m.wikimedia.org/wiki/File:Astrolabe_planisf%C3%A9rique_closeup800x600x300.jpg. Accessed September 30, 2018.

While the planispheric astrolabe is the most common form of astrolabe from an archeological perspective, there is considerable question as to whether it is the earliest.[20] Ancient peoples from many geographic regions have displayed an ability to use star motion and mathematical computation for navigational purposes long before the

invention of stereographic projection.[21] Whereas Greek and Arabic planispheric astrolabes model the hemispherical night sky on a two-dimensional plane, the historical record also attests to devices that used "azimuthal equidistant mapping," or the process of mapping the night sky onto a spherical object.[22] Because these spherical or "melon shaped" astrolabes (to which the Liahona would be most similar)[23] do not require stereographic projection, they are mathematically less complex than their planispheric counterparts, and devices functioning on similar principles may have pre-dated both Eudoxus and Hipparchus.[24] This would suggest that the earliest functioning astrolabes were most likely of the spherical variety, and the true genesis of astrolabe technology may then be much earlier than conservative estimates dictate. Indeed, the most recent archaeological evidence suggests that primitive astrolabe technology may date at least to the Babylonians, circa 650 BCE, and possibly several thousands of years earlier.[25] As such, it is entirely possible that a spherical device functioning on astrolabic principles may have existed at the time of Lehi.

Origin of the Liahona

Before comparing the functionality of the Liahona and ancient astrolabes, a discussion of the textual episode of the Liahona's appearance is warranted. After being commanded to leave Jerusalem, Lehi appears to have traveled the entire first portion of his journey unaided. His previous knowledge of the region was sufficient to allow his family to travel a significant distance from civilization while securing food, water, shelter, and other essential amenities for their journey.[26] Mid-expedition, the Lord felt the need to provide an additional means of navigation to supplement whatever resources Lehi had previously used to navigate the Judean wilderness. But where did such an instrument come from? What forces deposited such a valuable device outside the tent of a traveler in the middle of the Judean wilderness precisely as he was to begin the lengthier and more dangerous portion of his journey?

While the appearance of the Liahona has received no scholarly treatment to my knowledge, anecdotal origin theories typically ascribe the placement of the Liahona at Lehi's tent door to some form of heavenly messenger. Some individuals have gone as far as to suggest the instrument was both forged and placed at the tent door by God himself. These suggestions appear to stem primarily from a possibly misinterpreted portion of scripture: "the ball, or compass, which was *prepared for my father by the hand of the Lord* …" (2 Nephi 5:12, emphasis added). To grasp the meaning of this passage it is imperative to note other scriptural uses of the phrase, "hand of the Lord."[27] Virtually every other use of the

expression in the Book of Mormon describes a situation, circumstance, or event *orchestrated* by God rather than describing something physically performed by God himself.[28] Nephi uses an almost identical expression in an earlier portion of his record to describe the "much fruit" and "wild honey" found in the land Bountiful, two objects not created by God directly but instead naturally occurring materials (1 Nephi 17:5). EzraTaft Benson, the 13th president of The Church of Jesus Christ of Latter-day Saints, used the phrase in a modern context to describe the Book of Mormon itself, an object assumed to have been smelted, engraved, and buried by human hands. Referencing its miraculous preservation, President Benson stated, "[The Book of Mormon] was *prepared by the hand of the Lord* over a period of more than a thousand years, then hidden up by Him so that it would be preserved in its purity for our generation."[29] With such evidence that both ancient and modern prophets have used this phrase almost exclusively as a figurative expression, it seems unwise to interpret the expression in this context in a literal fashion. Consequently, the most reasonable explanation for the creation of the Liahona and for its placement at Lehi's tent door is that both were the result of human volition.

Important to this argument is the fact that, by his own admission, Nephi's account is both incomplete and spiritually oriented (1 Nephi 6:2–6; 19:2–7). His record is admittedly devoid of detail concerning specifics recorded in his other account, descriptions not deemed spiritually noteworthy, or situations not applicable to the reader. Nephi emphasizes that his record is to be a collection of spiritual happenings, designed and written to "show unto you that the tender mercies of the Lord are over all those whom he hath chosen, because of their faith, to make them mighty even unto the power of deliverance" (1 Nephi 1:20). This at least explains, in part, the dearth of information surrounding the Liahona's functionality and appearance. Rather than cloud his message by detailing the Liahona's mechanisms in too much specificity, Nephi appears to focus his writing on convincing the reader that God was integrally involved in leading his family to the Promised Land. Interestingly, Nephi never states or speculates how the Liahona appeared. Not until 2 Nephi 5:12 does Nephi even suggest that it was "prepared for my father by the hand of the Lord." When the Liahona first appears in the narrative, Nephi makes no claim that the creation, appearance, or function of the device was a display of God's power, but instead seems to emphasize the *timing* of the Liahona's appearance as the true miracle.[30]

The most logical suggestion for the origin of the Liahona, then, is that its appearance was in some way tied to the figure of Ishmael, a character

who enters the narrative almost simultaneously with the Liahona. The text also provides a plausible motive for Ishmael's giving the device to Lehi, as the verses preceding the first reference to the Liahona mention one of the most important customs of ancient Jews, the marriage covenant. No detailed examination of Jewish marriage customs will be attempted here, but even cursory understanding of Jewish dowry ritual provides a logical and natural explanation for the appearance of the Liahona. In 1 Nephi 16:7, Nephi details the marriage of his brothers and himself to the recently arrived daughters of Ishmael. Although the account is again vague, it can be reasonably assumed that the party may have attempted to observe the marriage customs of the day. The tradition that the father of the bride gives a dowry to the groom or his father was a common practice among ancient Jews.[31] Because of the antiquity of the record, little information is available concerning the details of the practice in the day of Lehi. However, this practice was performed by at least some Jews who predated Lehi, as specified in the marriage accounts contained in Genesis 24:59–61; 29:24, 29; Judges 1:15; and 1 Kings 9:16.[32]

As several of Ishmael's daughters married several of Lehi's sons, it is plausible that Ishmael would have given a collective dowry to Lehi, the father of the grooms, to distribute among the newly formed households. The giving of a dowry in the desert, away from society, would have severely limited the form in which the dowry could be given. Monetary compensation or a dowry of land was certainly not an option. Neither would food be a viable dowry, as food obtained by the party appears to have been communal.[33] Instead, an object that provided value in desert travel would seem a more appropriate option. An astrolabe is precisely such an instrument. As Ishmael appears to have been a trader or merchant,[34] it is certainly possible he had access to such a device. The appearance of the Liahona almost immediately following the arrival of Ishmael, and then directly following the marriage of Ishmael's children, provides at least reasonable textual evidence that the Liahona may have been part of or the entirety of a dowry Ishmael gave to Lehi. In such a case, Lehi's "great astonishment" (1 Nephi 16:10) at finding the ball in front of his tent would be astonishment that Ishmael adhered to Jewish customs that Lehi determined impractical or impossible given their current circumstances.

Comparative Functionality: Liahona and Astrolabes

The first parallels between a spherical astrolabe and the Liahona are the similarities in appearance and composition. Nephi describes the Liahona as "a *round ball of curious workmanship*; and it was of *fine brass*. And within the ball were two spindles; and the one pointed the way whither we should go in the wilderness" (1 Nephi 16:10, emphasis added). The description of a spherical astrolabe now housed in the Oxford Museum of the History of Science bears striking similarities: "it is a *finely worked* decorative object. *The brass globe* is made of two hemispheres that neatly screw together … The enclosing rete, which must rotate smoothly on the perfectly round sphere, *is also of brass*."[35] The parallels in description are remarkable, as the fine brass workmanship and the spherical shape of the astrolabe perfectly correlate to Nephi's description. Nephi also describes the ball as having two "spindles" which were "within the ball." While this description is often believed to denote pointers similar to those of a magnetic compass, it might also accurately describe the dually rotating retia — the net or cage-like portions of the astrolabe that rotate on a pivot or axle to represent the position of constellations in the night sky. These retia are literally *within* the ball, as they form the housing of the device, and each rotates in a manner that may accurately be described as a spindle. Additionally, it is not uncommon for portions of these retia to be described as "pointers," in reference to their function of pinpointing important information on the underlying globe that could be utilized to calculate the time of day at different latitudes.[36] An additional parallel between Nephi's description of the Liahona and a spherical astrolabe is *where* upon the ball Nephi says writing occurs: "And it came to pass that I, Nephi, beheld the *pointers* which were in the ball … And there was also written *upon them* a new writing, which was plain to be read …" (1 Nephi 16:28–29, emphasis added). Nephi states that the writing appeared "upon them [the spindles/pointers]," which is a curious place if the rest of the spherical instrument functioned as a casing for magnetic directional pointers. However, as can be seen in

Figure 2. Astrolabe, Museum of the History of Science, Oxford University. Inventory number 49687 from Syria, 1480/1 (A.H. 885). Image used under Create Commons License; https://commons.m.wikimedia.org/wiki/File:Spherical astrolabe 2.jpg. Accessed September 30, 2018.

figure 2, writing on spherical astrolabes is prominently placed on the retia or spindles of the device.

More impressive than appearance are the numerous similarities of function the astrolabe and Liahona share. One of the principal uses of the astrolabe is to triangulate direction. The Liahona too appears to have allowed Nephi to determine the direction the party was traveling (1 Nephi 16:13). After the Liahona appears, Nephi can accurately describe the direction of travel to the intercardinal direction "south-southeast," whereas prior to the Liahona's appearance, his descriptions of direction are definitively vague (see 1 Nephi 2:4–5). If the Liahona merely pointed toward the next destination, as has been traditionally assumed, it would be odd for the device to also convey directional information based on the cardinal directions. Astrolabes, however, allow location to be calculated in latitude and longitude using the position of the sun, constellations, or individual stars. Particularly useful in desert travel, these computations allow precise locational and directional calculation without relying upon landmarks, which are often nonexistent in desert terrain. It also allowed travelers to record the exact locations of water sources, infinitely increasing their ability to traverse the desert by allowing them to find the same point on a subsequent journey. Gazetteers including the location of these water sources were often stored on the astrolabe itself or on analog disks that could be interchanged dependent on region.[37] These disks, created from the knowledge of traders, nomads, or other explorers familiar with the area, contained star charts, details about the area, and even the coordinates for water sources located nearby. This information would allow someone like Lehi to locate water in a region he had never before traveled. Note Nephi's words: "And we did follow the *directions of the ball*, which led us in the *more fertile parts of the wilderness*" (1 Nephi 16:16, emphasis added). The most fertile places in the desert are locations where the presence of water allows for the growth of plant life. Traders – possibly Ishmael himself – who had followed the same route Lehi took across the peninsula would have discovered and recorded the location of these oases on the Liahona prior to Lehi's journey. Because astrolabes could be used to record (and subsequently rediscover) an almost limitless amount of regional information, it should be noted that a Liahona functioning on astrolabic principles is equally compatible with any proposed reconstruction of Lehi's route of travel from Jerusalem to Bountiful.[38]

One of the greatest challenges in desert travel, and one shared by Lehi's caravan, is locating sources of food for the journey. As game in the desert primarily congregate near water, being able to locate oases also

would allow a party to locate possible hunting grounds to supplement their stores of food. Nephi and Lehi's use of the Liahona to locate food thus provides another valuable correlation between the Liahona and an astrolabe. The textual incident that illustrates this connection can be found in 1 Nephi 16:18–32. After Nephi breaks his bow and is unable to find food for several days (1 Nephi 16:18–19), Nephi constructs another bow but is unsure where to go to find game to hunt. His initial faith-based response is to inquire of his father, who in turn inquires of the Lord where to go to find food (1 Nephi 16:23–24). Rather than providing the information directly, the Lord curiously responds by telling Lehi to look upon the ball for information.[39] Lehi does so, and as he looks upon the ball he discovers writing that provides Nephi with directions to a place where he could obtain food.[40] It is clear from the text that until this time (several weeks, if not months from Nephi's description),[41] previous writing had been found on the ball but had caused no particular stir.

Instead, in this episode "new writing" is discovered, the content of which made it worth mentioning (1 Nephi 16:29). Because a word for word description of the writing is not provided, some misconceptions regarding the information conveyed have arisen. To correctly understand the content of the message contained on the ball, it is important to remember the question that had been asked and was subsequently answered by the writing. After reading the inscription, the text states that Nephi "did go forth up into the top of the mountain, *according to the directions which were given upon the ball*. And it came to pass that [he] did slay wild beasts, insomuch that [he] did obtain food for [their] families" (1 Nephi 16:30–31, emphasis added). The ball appears to have told Nephi where a water source was located and where, inherently, he could find game to hunt. If such is the case, some explanation must be given for why the writing on the ball caused Lehi to "quake and fear exceedingly" (1 Nephi 16:27).

As water generally flows to the lowest topographical point in any given region, directions provided by the ball specifying that a water source would be found at the top of a mountain would have seemed counterintuitive to Lehi and his party. This irregularity may have been the cause of Lehi's consternation because if water was not indeed located at the place specified by the ball, the party was likely to starve. The "appearance" of new writing on the ball is not incongruent with the functionality of an astrolabe. As calculations are made at different times of day or night, the rete of the astrolabe is turned to accurately mirror the visible position of the referential celestial body. As the rete is manipulated, different portions of the underlying globe or disks become

visible, possibly revealing previously unseen writing.[42] Subsequently, as Nephi or Lehi calculated the party's location at different times of the day, month, or year, different portions of the disks could be read, and the writing would be changed "from time to time," a very literal reading of Nephi's phrase (1 Nephi 16:29). This interpretation does not necessarily preclude traditional understandings that the writing on the Liahona may have contained spiritual guidance. Indeed, ancient astrolabes have a long history of spiritual application:

> Astrolabes had blended uses, from scientific to what we would today consider spiritual. They have a strong history in Islam as a tool to find both the direction of prayer toward Mecca — known as the Qibla — as well as the five times of prayer required throughout the day, as stated in the Quran. They later became popular amongst Europeans during the Middle Ages as an astrological tool …[43]

In addition to being used for astrological divination, writing on astrolabes often contained religious maxims, scriptural verses, or other spiritually pertinent information along with geographical information.[44] These common spiritual uses provide at least some corroboration with Nephi's claim that the Liahona provided "understanding concerning the ways of the Lord." Additionally, it is possible the "understanding" Nephi derived from the writing was a more appreciative awareness that the Lord often utilizes ordinary means to answer the prayers of his children. Nephi and Lehi, who appear to have relied tremendously on revelation to direct their lives, may have gained a more profound understanding of this "way of the Lord," as when they expected an answer to come via a direct revelatory experience, their attention was directed back to a physical device.

Internal Workings of the Liahona

Opponents may refute this theory, citing 1 Nephi 16:28 as evidence of the miraculous nature of the Liahona: "And it came to pass that I, Nephi, beheld the pointers which were in the ball, that they did work according to the faith and diligence and heed which we did give unto them." This verse is often associated and correlated with Alma 37:40: "And [the Liahona] did work for them according to their faith in God; therefore, if they had faith to believe that God could cause that those spindles should point the way they should go, behold, it was done; therefore, they had this miracle, and also many other miracles wrought by the power of God, day by day." What

readers often fail to realize is that these two accounts do not actually agree about many aspects of the Liahona's functionality.

There are three distinct differences between the account of the Liahona as provided by Nephi and the account provided by Alma: (1) the workmanship of the device, (2) the functionality of the device, and (3) the name of the device.[45] In attempting to reconcile the differences between the two accounts it is important to note that Alma's account was written nearly 500 years after Nephi and his family left Jerusalem. If the Book of Mormon is treated as a cultural or historical text, Nephi's account should be given primacy in any attempt to reconstruct the Liahona's functionality.

When Nephi first encounters the Liahona he states that he " … beheld upon the ground a round ball of curious workmanship; and it was of fine brass" (1 Nephi 16:10). It seems that while Nephi was impressed with the quality of the workmanship of the Liahona, its physical appearance was not evidence of its miraculous nature. Consider for instance, that Nephi uses a nearly identical phrase to describe his own labors building a ship: " … and we did work timbers of *curious workmanship* … And it came to pass that after I had finished the ship … my brethren beheld that it was good, *and that the workmanship thereof was exceedingly fine*" (1 Nephi 18:1, 4, emphasis added). Furthermore, Nephi seems to be more impressed with the workmanship of Laban's sword than with the workmanship of the Liahona.[46] While Nephi certainly recognizes the excellent quality of the Liahona and may not be able to replicate it despite his own considerable metallurgical skills,[47] he does not appear to view the workmanship of the object itself as miraculous. Indeed, the most applicable definition of "curious" from the 1828 Webster dictionary is "wrought with care and art; elegant; neat; finished." Alma, on the other hand, is far more impressed by its appearance: "And behold, *there cannot any man work after the manner of so curious a workmanship*."[48] This subtle, yet significant change in description about the Liahona's workmanship is highly indicative of a shift in cultural understanding about the Liahona, its origins, and its functionality.

This cultural shift regarding the Liahona is further apparent when comparing Nephi and Alma's description of the Liahona's functionality. Nephi's descriptions of how the Liahona functioned found in 1 Nephi 16:28 must be viewed in the context of Nephi's journey up to that point. If Nephi and his family had been following the Liahona's direction for weeks without questioning, it seems odd they didn't discover the Liahona functioned according to faith, diligence, and

heed to the commandments of God until Nephi broke his bow. In fact, this conception can be derived only from Nephi's words when viewed in conjunction with the passage in Alma. Nephi states that the ball functioned according to the faith, heed, and diligence they gave *unto the pointers of the ball*, not the commandments of the Lord.[49] This is fundamentally different from Alma's claim that the Liahona functioned or failed based on their "… faith *in God*" (Alma 37:40, emphasis added). Nephi never states that the ball ceased to work if they did not have faith in God. In fact, in Nephi's account the party's faith is exclusively tied to the conditions of the journey, not whether the ball provided them directions. This can be seen in the words of Nephi:

> And it came to pass that the Lord was with us, yea, even the voice of the Lord came and did speak many words unto them, and did chasten them exceedingly; and after they were chastened by the voice of the Lord they did turn away their anger, *and did repent of their sins, insomuch that the Lord did bless us again with food, that we did not perish*. (1 Nephi 16:39, emphasis added)

Here, Nephi equates disobedience with an inability to locate food, not with a Liahona that ceased to function. This mentality is mirrored when the party is on the ship crossing the sea, and Nephi's brothers begin to grow careless. Nephi's admonishment to them is that a storm may arise because of their revelry, not that the Liahona will cease to function (1 Nephi 18:10).

If the Liahona functioned based on the attention and care that Nephi's party gave to the ball itself, one might still ask why Nephi describes the process using the words "faith, heed, and diligence." Joseph Smith, the translator of the Book of Mormon, said, "[w]e understand that when a man works by faith he works by *mental exertion* … "[50] Mathematical computations are an integral aspect of astrolabe navigation, matching the "mental exertion" Joseph Smith described. "Diligence" is defined in the 1828 Webster dictionary as: "Steady application in business of any kind; constant effort to accomplish what is undertaken; *exertion of body or mind without unnecessary delay or sloth*." In the same dictionary, "heed" is defined as: "To mind; to regard with care; *to take notice of*; to attend to; to observe." Attention paid to calculations, the exertion of body and mind to follow the directions provided, and the trust placed in the accuracy of the directions of the ball certainly qualify as exercising faith, heed, and diligence.

If the Liahona was indeed a gift from Ishmael, Ishmael would have been the primary navigator for the party until his death. Nephi and Lehi would have had to learn from Ishmael how to perform the calculations

necessary to find the next water source in the wilderness, and then the party had to trust that the calculations were correct. It is interesting that Nephi's first true description of the ball's mechanisms comes a short time before the death of Ishmael.[51] It is quite likely Ishmael became seriously ill prior to his death, a fact that may have severely limited his ability to manipulate the device, thus necessitating Lehi and Nephi's assistance. These conditions would not only explain Nephi's belated discussion of the device's functionality, but also explain the consternation the party experienced at following the directions of the ball, which seems to occur only after Ishmael's death. Indeed, as the narrative progresses, the party seems to have *more* difficulty following the directions of the ball, not less, despite their continued success. While Nephi appears to be an integral part of the company throughout the narrative, he does not appear to take primary responsibility of navigating the party until after the death of Ishmael. This is shown in the text as complaints and accusations about Nephi's leading the company occur a long while after the appearance of the Liahona and only after Ishmael has been buried (1 Nephi 17:20). This view is also strongly supported by the interesting complaint of Ishmael's family at his death:

> And it came to pass that the daughters of Ishmael did mourn exceedingly, because of the loss of their father … saying: Our father is dead; yea, and we have wandered much in the wilderness, and we have suffered much affliction, hunger, thirst, and fatigue; and *after all these sufferings we must perish in the wilderness with hunger.* (1 Nephi 16:35, emphasis added.)

This complaint is unique in several aspects. First, with Ishmael dead, odds of survival for the party actually increased, as there would be more food and water for the company with one fewer dependent. Second, the caravan could then move faster without an aged and possibly ill member to worry about. Instead, it appears that Ishmael's daughters are convinced the death of their father would bring about their deaths as well. It would seem that they, along with other members of the party, were skeptical that Nephi and Lehi could correctly utilize the Liahona to guide them to their destination. This fear would be wholly unfounded if the Liahona worked in the strictly faith-based manner assumed by most Book of Mormon readers. When the party ceased to trust Nephi's calculations and did not follow the directions of the ball (in other words, exercising their faith) they were "afflicted with hunger and thirst," substantive evidence of difficulty locating a water source (Alma 37:42). Additionally, they "did not progress in their journey … or did not travel

in a direct course" — also suggestive of a difficulty in locating the next oasis to make their base camp — and were instead "driven *back*…" (presumably to the last known water source) "and therefore they were *smitten with famine* and sore afflictions, to stir them up in remembrance of their *duty*" (Mosiah 1:17).[52] Each of these observations correspond well with the assertion of Chadwick "that the great majority of the 'eight years in the wilderness' is to be counted after Nahom."[53] The relative inexperience of Nephi and Lehi in utilizing the Liahona to direct their journey is a plausible explanation for both the inflated length of time spent in the wilderness after Nahom and the navigatory difficulties the party appears to have experienced only after the death of Ishmael.

Further evidence that Nephi may have used mathematical computations in the working of the Liahona is found in his brothers' accusations:

> And Laman said unto Lemuel and also unto the sons of Ishmael: "Behold, let us slay our father, and also our brother Nephi, *who has taken it upon him to be our ruler and our teacher*, who are his elder brethren…behold, we know that he lies unto us; and he tells us these things, and *he worketh many things by his cunning arts, that he may deceive our eyes, thinking, perhaps, that he may lead us away into some strange wilderness*. (1 Nephi 16:37–38, emphasis added)

First, Nephi's brothers seem to suggest that Nephi has only recently "taken it upon him[self]" to become some sort of leader on the journey. The "cunning arts" of which Nephi is accused are a natural description of astrolabic navigation techniques by anyone unfamiliar with trigonometric computation. Later, after following the Liahona for *eight years*, Laman and Lemuel are still plagued with doubts, and in their minds it is easy to confuse Nephi's leadership in the desert with God's workings of the Liahona. This confusion would be borderline psychotic if the Liahona in fact successfully and repeatedly functioned in a clearly spiritual way. It is far easier to explain the actions and attitudes of Laman and Lemuel if Nephi was indeed utilizing a naturally functioning navigation device to lead the party.

Nephi's Manipulation of the Liahona

Perhaps the most convincing episode that provides evidence that the functionality of the Liahona was directly tied to Nephi's manipulation occurs when the Liahona is used in the journey across the sea. One of the most useful functions of an astrolabe is that the techniques used for calculating position on land are also applicable to sea travel;

indeed, variations of the astrolabe have been used in sea navigation for thousands of years.[54] After using the Liahona for nearly a decade (1 Nephi 17:4), before setting out into the ocean for the final portion of their journey, the Lord tells Nephi: "*After* ye have arrived in the promised land, ye shall *know* that I, the Lord … did bring you out of the land of Jerusalem" (1 Nephi 17:14, emphasis added). This statement suggests that the guidance of the Liahona after eight years was still not viewed as conclusive evidence that God was directing their path. Instead, crossing the sea to an uncharted land would provide the evidence necessary to prove that God was the one leading the party. This is consistent with the fact that all previous cartographical information contained on the Liahona would have been recorded on the device by its previous owners. As such, Nephi's using the device to navigate to an unrecorded location would be a powerful display of God's involvement. Perhaps the requisite navigational information for the journey was an example of the "great things" the Lord showed Nephi (1 Nephi 18:3).

After traveling on the water for an unspecified period, a portion of Nephi's party began to revel in the success of their journey. Nephi's brothers and other members of the band began to "dance, and to sing, and to speak with much rudeness" (1 Nephi 18:9). The most offensive part of their festivities occurs when they commit the unthinkable act of "forget[ting] by what power they had been brought thither" (1 Nephi 18:9). Even after following the Liahona for eight years, possibly because of the natural means by which the Liahona functioned, it was easy for members of the party to forget that God was leading them. It is also interesting to note that although at this moment the party had ceased to exercise the traditional definition of "faith, heed, and diligence," Nephi gives no indication that the Liahona had ceased to function. In fact, there is never a specific account in Nephi's narrative to this point that details an instance of the Liahona's ceasing to operate. Nephi warns his brothers that they need to repent of their iniquity, but his warning is not that the Liahona will cease to function. Instead, he is worried that a storm may arise and sink the ship (1 Nephi 18:10). Laman and Lemuel's response to Nephi's concern is telling: "We will not that our younger brother shall be a ruler over us" (1 Nephi 18:10). Again, the focus of their complaint is that Nephi is somehow in charge of the expedition, and in retaliation they bind Nephi. Nephi then records: "The Lord did suffer it that he might show forth his power" (1 Nephi 18:11). Nephi viewed his bondage as an episode the Lord allowed to demonstrate more effectively that indeed God, not Nephi, was leading the party. Nephi stated that as soon as he had been bound, "the compass, which had been prepared of the Lord,

did cease to work" (1 Nephi 18:12). As Nephi was the one manipulating the device, this statement is indeed true but not in the sense that it appeared broken or that it ceased to function entirely. This is demonstrated by the fact that it took Nephi's brothers four days before they realized that something was wrong: "And after we had been driven back upon the waters for the space of four days, my brethren *began* to see that the judgments of God were upon them" (1 Nephi 18:15, emphasis added). There is at least some sense that the Liahona ceased to function because the storm would have obscured the party's view of the sun and the stars, thus preventing Nephi's brothers from using the device to navigate. Shortly after Nephi is released from his bondage, he states: "Behold, I took the compass, and it did work whither *I desired it*" (1 Nephi 18:21, emphasis added). The usually deferential Nephi is careful to detail that he was the one working the compass after his release. The compass worked only for him, and it worked even before Nephi prayed to the Lord for the storm to cease. Nephi then states: "*I Nephi*, did guide the ship, that we sailed again towards the promised land" (1 Nephi 18:22, emphasis added). Nephi appears to have had a much more integral role in manipulating the compass than a casual reading of the text would suggest.

Conclusion

After arriving in the promised land, Lehi described Nephi's role in the journey thus: "[He] hath been an instrument in the hands of God, in bringing us forth into the land of promise; *for were it not for him, we must have perished with hunger in the wilderness*" (2 Nephi 1:24, emphasis added). It is difficult to shake the impression that in this verse Lehi is making a deliberate comparison between Nephi and the Liahona itself. Just as the Liahona was "an instrument" in the hands of Nephi to guide the party through the wilderness, so too was Nephi an "instrument in the hands of God," used as a tool to guide the party to the promised land. Nephi's integral role in the use of the Liahona clearly suggests similarities in use and function to astrolabes used by astronomers throughout the ancient Near East. This new understanding of the Liahona provides greater meaning to the words of Nephi, "and thus we see that by small means the Lord can bring about great things" (1 Nephi 16:29).

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Endnotes

1. Brigham Young, *Journal of Discourses* (Liverpool: Latter-Day Saints Book Depot, 1871), 13: 140, 306.
2. Hugh Nibley, "The Liahona's Cousins," *The Improvement Era* (February 1961): 88.
3. For examples of these attempts see George Q. Cannon, *The Life of Nephi The Son of Lehi* (Salt Lake City: Juvenile Instructor Office, 1883), 38; B.H. Roberts, *A New Witness for God* (Salt Lake City: George Q. Cannon & Sons, 1895), 550–5 2; Robert F. Smith, "Lodestone and the Liahona," in *Reexploring the Book of Mormon*, ed. John W. Welch (Salt Lake City, UT: Deseret Book, 1992), http://publications.maxwellinstitute.byu.edu/fullscreen/?pub=1110&index=12; Robert L. Bunker, "The Design of the Liahona and the Purpose of the Second Spindle," *Journal of Book of Mormon Studies 3*, vol. 2 (1994): 1–11; Alan C. Miner, *The Liahona: Miracles by Small Means* (Springville, UT: Cedar Fort Inc., 2013).
4. Smith, "Lodestone and the Liahona."
5. Ibid.

6. See Bob Burns and Mike Burns, *Wilderness Navigation: Finding Your Way Using Map, Compass, Altimeter & GPS* (Seattle: Mountaineers Books, 2015).
7. "And we did follow the directions of the ball … " 1 Nephi 16:16.
8. "And it came to pass that the voice of the Lord came unto my father; and he was truly chastened." 1 Nephi 16:25–26. "And it came to pass that the Lord was with us, yea even the voice of the Lord came and did speak many words unto them, and did chasten them exceedingly" 1 Nephi 16:39. Consider also the directions Nephi receives from the Lord on building a ship found in 1 Nephi 17:7–10. Nephi frequently records experiences of direct communication with the Lord, but never claims to have received any sort of directional guidance from those interactions.
9. Consider that when Lehi prays for direction on where Nephi should go to find food, the Lord directs Lehi's attention back to the information provided by the ball, rather than providing the direction in the same revelatory experience. See 1 Nephi 16:26, 30.
10. Admittedly, this is a simplified description of an astrolabe's functionality. The mathematic calculations used in conjunction with astrolabes are highly complex and only tangentially provide navigation information by allowing the user to calculate current latitude and longitude based on the position of fixed celestial bodies. Using this positional information, one could then infer position relative to the latitude and longitude of known cities, oases, etc. Hence, an astrolabe's greatest navigational use is to calculate the positional information of specific locations and store that information for a later return. Without this, or comparable technology, consistent desert travel would be nearly impossible for caravans such as Nephi's as they would be unable to find small, isolated oases which lack discernable landmarks demarcating them from the surrounding desert. For a simple discussion of the astrolabe's basic functionality see Laura Poppick, "The Story of the Astrolabe, the Original Smartphone," Smithsonian Magazine (website), January 31, 2017, https://www.smithsonianmag.com/innovation/astrolabe-original-smartphone-180961981/.
11. Bruce Watson, "The Astrolabe: Astronomy's First Hot App," *Sky and Telescope* 131, no. 2 (2016): 24–27.

12. "Regular trade was carried on between the island of Crete and Egypt, a distance of approximately 300 miles (500 km), more than 25 centuries before the Christian era ... The details of how these voyagers found their way are not known, but the use of the Sun and stars as guides is mentioned in many sources, including the works of Homer and Herodotus, the Bible, and the Norse sagas." Encyclopaedia Britannica Online, s.v. "Navigation," accessed September 19, 2018, http://www.britannica.com/EBchecked/topic/407011/navigation.
13. Primitive star navigation is typically understood to have provided only rudimentary, or "spatial," navigation information. That is to say, primitive star navigation primarily yielded directional, not positional, information. As such the standardized calculations and methods surrounding astrolabe technology provided for the ancients, not only (but also)?? a larger wealth of available knowledge, but also a tool by which navigational information became positional and standardized.
14. Watson, "The Astrolabe," 24.
15. Robert T. Gunther, *The Astrolabes of the World*, vol. 1, The Eastern Astrolabes (Oxford: Oxford University Press, 1932), 53.
16. Ibid.
17. "It is customary to refer to the Planispheric Astrolabe … as the invention of the great Alexandrian savant, Hipparchus of Bithynia, born c. 180, died c. 125 B.C. It is said that he was the first man to apply a theory of stereographic projection to the drawing of the celestial sphere upon the plane of the equator. The planispheric astrolabe is impossible without this projection, so that if Hipparchus had really been the first exponent of this projection, there could have been no astrolabe before his day." Gunther, *The Astrolabes of the World*, 53.
18. Gunther, *The Astrolabes of the World*, 53–54.
19. Ibid.
20. E.S. Kennedy, P. Kunitzsch and R. P. Lorch, trans. and ed., *The Melon-Shaped Astrolabe in Arabic Astronomy* (Germany: Franz Steiner Verlag Stuttgart, 1999), 5.
21. See Michael Halpern, "Sidereal Compasses: A Case for Carolinian-Arab Links," *The Journal of the Polynesian Society* 95, no. 4

(1986): 441–59; Ora Negbi, "Early Phoenician Presence in the Mediterranean Islands: A Reappraisal," *American Journal of Archaeology* 96, no. 4 (1992): 599–615; Christos Agouridis, "Sea Routes and Navigation in the Third Millennium Aegean," *Oxford Journal of Archaeology* 16, no. 1 (1997): 1–24; Douglas T. Peck, "Development of Celestial Navigation by the Ancient Maya," *The Journal of Navigation* 4, no.1 (January 2001): 145–49.

22. Kennedy, Kunitzsch and Lorch, *The Melon-Shaped Astrolabe*, 1–4.
23. Refer to Figure 2 for a visual reference of a spherical astrolabe.
24. Kennedy, Kunitzsch and Lorch, *The Melon-Shaped Astrolabe*, 1–4.
25. Richard Talbert, ed., *Ancient Perspectives: Maps and Their Place in Mesopotamia, Egypt, Greece & Rome* (Chicago: The University of Chicago Press, 2012), 37–39.
26. " … I, of myself, have dwelt at Jerusalem, wherefore I know concerning the regions round about;" 2 Nephi 25:6, (emphasis added). It seems that Nephi and Lehi were the principle guides in the wilderness for the first portion of the journey. Nephi's knowledge of the area seems to be enough to allow his family to travel away from Jerusalem, set up a camp at a suitable location, and then return to Jerusalem two times without issue. Curiously, accusations about Nephi guiding the party only occur after the company begins following the Liahona and notably after the death of Ishmael. It would seem that the group trusted Nephi and Lehi's guidance initially and became concerned only when the party struck out into unfamiliar territory using a device most of them did not know how to use.
27. See 2 Nephi 1:5–6; 2 Ne. 28:6; Omni 1:16; Mosiah 1:1–5; Mosiah 2:11; Mosiah 28:15; Alma 2:28; Alma 37:4; Alma 45:19; see also Moses 1:4; Moses 7:32.
28. Consider, for example, Nephi's tendency to attribute to the Lord events which he himself physically performed. Despite being the individual most responsible for the food and provisions of the company, Nephi says in 1 Nephi 16:11 that they "gather[ed] together whatsoever things [they] should carry into the wilderness, and all the remainder of [their] provisions which the Lord had given unto [them]" (emphasis added). The ever-deferential Nephi sees the "hand of God" in nearly every aspect of his life. Nephi attempts to display to the reader, who was not present at these events, that

the Lord was involved in a grand guiding way, not physically performing the acts.

29. Ezra Taft Benson, "The Book of Mormon—Keystone of Our Religion," *Ensign* (November 1986), emphasis added.

30. Just prior to detailing the Liahona's appearance, Nephi carefully informs the reader of the commandment the Lord gave to Lehi to reassume his journey the next day. Nephi seems to be attempting to display that the Liahona was provided to Nephi's party at precisely the moment when Lehi needs the instrument to fulfill the commandment of the Lord. Nephi does not seem overly awed by its origin, composition, or even functionality. His primary interest in the device is that it appeared when his family needed it the most. To Nephi, the timing of the Liahona's delivery is the miracle.

31. "Besides this custom of the bridegroom making gifts to the bride or paying a ransom to her father the Bible also makes frequent mention of property which the woman brought to her husband at marriage. Rebekah brought to her new home female slaves from her father's household (Genesis xxiv. 59, 61). Laban made similar gifts to Leah and to Rachel (Genesis xxix. 24, 29). Othniel at marriage received from his father-in-law, Caleb, a field of springs (Judges i. 15). Solomon received from Pharaoh, his father-in-law, a city as the portion ('shilluḥim') of the princess (I Kings ix. 16). Later, the practise of giving a dowry to a daughter, as it is now understood, entirely superseded the gift or ransom given by the groom; so that in Talmudic times it ('nedunya') is spoken of as a long-established custom." Jewish Encyclopedia, s.v. "Dowry," accessed September 19, 2018, http://www.jewishencyclopedia.com/articles/5297-dowry.

32. Ibid. See also: Phillip J. King, Life in Biblical Israel (Louisville: Westminster John Knox Press, 2001), 54.

33. See 1 Nephi 16.

34. Hugh Nibley, Lehi in the Desert and the World of the Jaredites (Salt Lake City: Deseret Books, 1988), 36, https://publications.mi.byu.edu/fullscreen/?pub=1106&index=5.

35. *Oxford Museum of the History of Science*, "Special Exhibition Label: 'Al-Mizan: Sciences and Arts in the Islamic World' (26/10/2010 - 20/03/2011)", accessed September 19, 2018, http://www.mhs.ox.ac.

uk/collections/imu-search-page/narratives/?irn=2113&index=2, emphasis added.

36. Anthony Turner, "Concerning a Pointer on the Astrolabe," *Journal for the History of Astronomy* 46, no. 4 (2015): 413–18.
37. Kennedy, Kunitzsch and Lorch, *The Melon-Shaped Astrolabe*, 1. See also Richard Covington, "The Astrolabe: A User's Guide," *Aramco World* 58, no. 3 (2007): 22–23, http://archive.aramcoworld.com/issue/200703/the.astrolabe.a.user.s.guide.htm.
38. For an introduction to the three predominant route reconstructions see: Jeffrey R. Chadwick, "An Archaeologist's View," *Journal of Book of Mormon Studies* 15, no. 2 (2006): 68–77, 122–24.
39. "And I said unto my father: Whither shall I go to obtain food? And it came to pass that he did inquire of the Lord … And it came to pass that the voice of the Lord said unto him: Look upon the ball, and behold the things which are written." 1 Nephi 16:23–24, 26.
40. "And it came to pass that I, Nephi, did go forth up into the top of the mountain, according to the directions which were given upon the ball." 1 Nephi 16:30, emphasis added.
41. "traveled for the space of many days … pitch our tents for the space of a time," 1 Nephi 16:17.
42. Kennedy, Kunitzsch and Lorch, *The Melon-Shaped Astrolabe*, 1–3.
43. Poppick, "The Story of the Astrolabe."
44. Emily Winterburn, "Using an Astrolabe," Foundation for Science Technology and Civilisation (2005), http://muslimheritage.com/article/using-astrolabe.
45. Only the first two differences are discussed at length in this paper. However, it is interesting that none of the characters in the Book of Mormon directly involved with the instrument refer to it as the "Liahona." Instead, Nephi exclusively refers to the device as a "ball," "compass," or "director." It is possible that this indicates a familiarity with technology similar to the Liahona, as Nephi appears to have had three words he felt accurately described the functionality of the device. The word "Liahona," then, appears to be a name given by subsequent generations to describe the instrument as it functioned in the story of the Lehite exodus. Scholars have suggested a variety of possible meanings of the word based on its probable Hebrew etymology. While there is not yet a scholarly

consensus on the etymological meaning of the word "Liahona," the most probable interpretation appears to be "the direction (director) of the Lord." See Jonathan Curci, "Liahona: 'The Direction of the Lord': An Etymological Explanation, Journal of Book of Mormon Studies 16, vol. 2 (2007): 60–67, 97–98. Alternatively, some scholars have proposed the meaning of the word Liahona corresponds to the Liahona's function of helping Lehi's company find their way from one encampment to another and should thus be rendered "encamping for Yahweh." This meaning would correspond to the hypothetical Hebrew word *layahone*, "encamping for Yahweh," derived from the participle form of the Hebrew verb *hānā*, "to pitch (tent), encamp, dwell." This proposed etymology corresponds with a notion that the Lehites may have viewed themselves as participating in an "exodus," similar to that of the Hosts of Israel, as evidenced by what appear to be explicit Exodus motifs in the account. See George S. Tate, "The Typology of the Exodus Pattern in the Book of Mormon," in N. E. Lambert, ed., *Literature of Belief: Sacred Scripture and Religious Experience* (Provo: BYU Religious Studies Center, 1981): 245–62, https://rsc.byu.edu/archived/literature-belief-sacred-scripture-and-religious-experience/13-typology-exodus-pattern-book; See also: S. Kent Brown, "The Exodus Pattern in the Book of Mormon," *BYU Studies Quarterly* 30, no. 3 (Summer 1990): 111–26, https://rsc.byu.edu/archived/jerusalem-zarahemla-literary-and-historical-studies-book-mormon/exodus-pattern-book-mormon. In any case, the proposed etymologies suggest that the name given to the device may have functioned as a mnemonic device used by Lehi's descendants to reinforce the moral and spiritual force of the account as they recounted the narrative to their children. Because it is highly likely that the majority of Lehi's descendants would have primarily encountered these stories orally, providing a name for the device that described its function and/or reinforced its connection to the divine (the theophoric element of the word) could assist in helping hearers remember the details of their national origin story as well as properly ascribe the success of their journey to the Lord. This would stand in stark contrast to the Lamanite recollection of the Lehite exodus and subsequent ocean crossing, which appears to focus entirely on the role played by Lehi and Nephi rather than on any divine involvement. See Mosiah 10:12–13.

46. "And I beheld his sword, and I drew it forth from the sheath thereof; and the hilt thereof was of pure gold, and the workmanship thereof

was exceedingly fine, and I saw that the blade thereof was of the most precious steel." 1 Nephi 4:9.

47. Nephi is able to make metal plates, metal tools, and even replicates of the sword of Laban. Nephi does not, however, attempt to recreate the Liahona despite it being a metal object. For Nibley's assertion that Lehi and Nephi may have been metalsmiths see: Nibley, *Lehi in the Desert*, 85.

48. Alma 37:39, emphasis added. Alma's phrase could alternatively be interpreted as referring to the abilities of individuals of his day, not necessarily mankind as a whole.

49. 1 Nephi 16:28: "And it came to pass that I, Nephi, beheld the pointers which were in the ball, that they did work according to the faith and diligence and heed which we did give unto them" (emphasis added).

50. Joseph Smith, "Lecture Seventh of Faith," in Lectures on Faith (Springville, UT: Cedar Fort, 2010).

51. The two occur only six verses apart. See 1 Nephi 16:28 and 1 Nephi 16:34.

52. Emphasis added. See also Alma 37:41.

53. Chadwick, "An Archaeologists View," 74.

54. Encyclopedia.com, s.v. "Astrolabe," accessed October 17, 2012, http://www.encyclopedia.com/doc/1G2–3 437800039.html.