

Secrets of the Viking Ships

Their hulls differed greatly from those of traditional square-riggers. Here's why a unique Norse take on naval architecture made the Viking longboats a legend that still flourishes today.

By David W. Shaw

IN THE FALL OF 1879, TWO TEEN-age boys on the Gokstad farm in Sandefjord, Norway, decided to do some digging in an old Viking burial mound on the property. The mound was well known to locals. In fact, they named it the “king’s mound” because it was so massive—about 16 feet high with a diameter of nearly 150 feet.

As the kids dug in the peat and clay, they unearthed what appeared to be the remains of a ship. Of course they couldn’t be sure, but they went home saying they’d found something mighty interesting in the king’s mound. Word spread, finally reaching an influential antiquarian expert at the University of Oslo. After investigating the site, he determined that the mound was home to a Viking ship.

Excavation began in 1880. The ship was meticulously restored and new timbers were added when the original parts were beyond repair. The vessel, known as the Gokstad ship, is on display at the Viking Ship Museum in Oslo. It’s a magnificent sight that inspires imaginings of the Viking Age. It also provides fascinating evidence that helps clarify why these open boats were capable of crossing the North Atlantic on epic journeys of exploration at a time when Europe languished in the tumultuous Dark Ages.

Just what was the secret of the Viking ship? What made these vessels so formidable as war machines and sea boats? Was there something unique in the design from a naval architecture perspective, or did the success of the Viking ship derive from other factors, like construction methods and the seamanship of the captains and crews? Unlocking the mystery of the Viking ship involves playing the role of maritime detective. The clues that give us some answers are found in specimens like the venerable Gokstad ship.

The Gokstad ship is one of the best-preserved Viking longships in the world because it was buried below ground level in thick blue clay that acted as a shield against rot and utter deterioration of its oak frame and pine deck. At 75 feet in length with a beam of 16 feet, the vessel provides a remarkable glimpse back in time. Archaeologists have dated the ship to around 890 C.E., more than 100 years before Leif Ericson’s famous transatlantic voyage to Canada and more than 600 years before Christopher Columbus made his historic voyage to the New World in 1492. The warship was built at the height of the Viking Age, which ran from about 700 to roughly 1100 C.E.

The Gokstad ship carried a crew of 34, with 16 oar stations on each side. Interestingly, the oar holes are only 16 inches above the deck. No thwarts were found. It is thought that the oarsmen used their private sea chests as benches. While the lack of thwarts may strike some of us as a bit odd, their

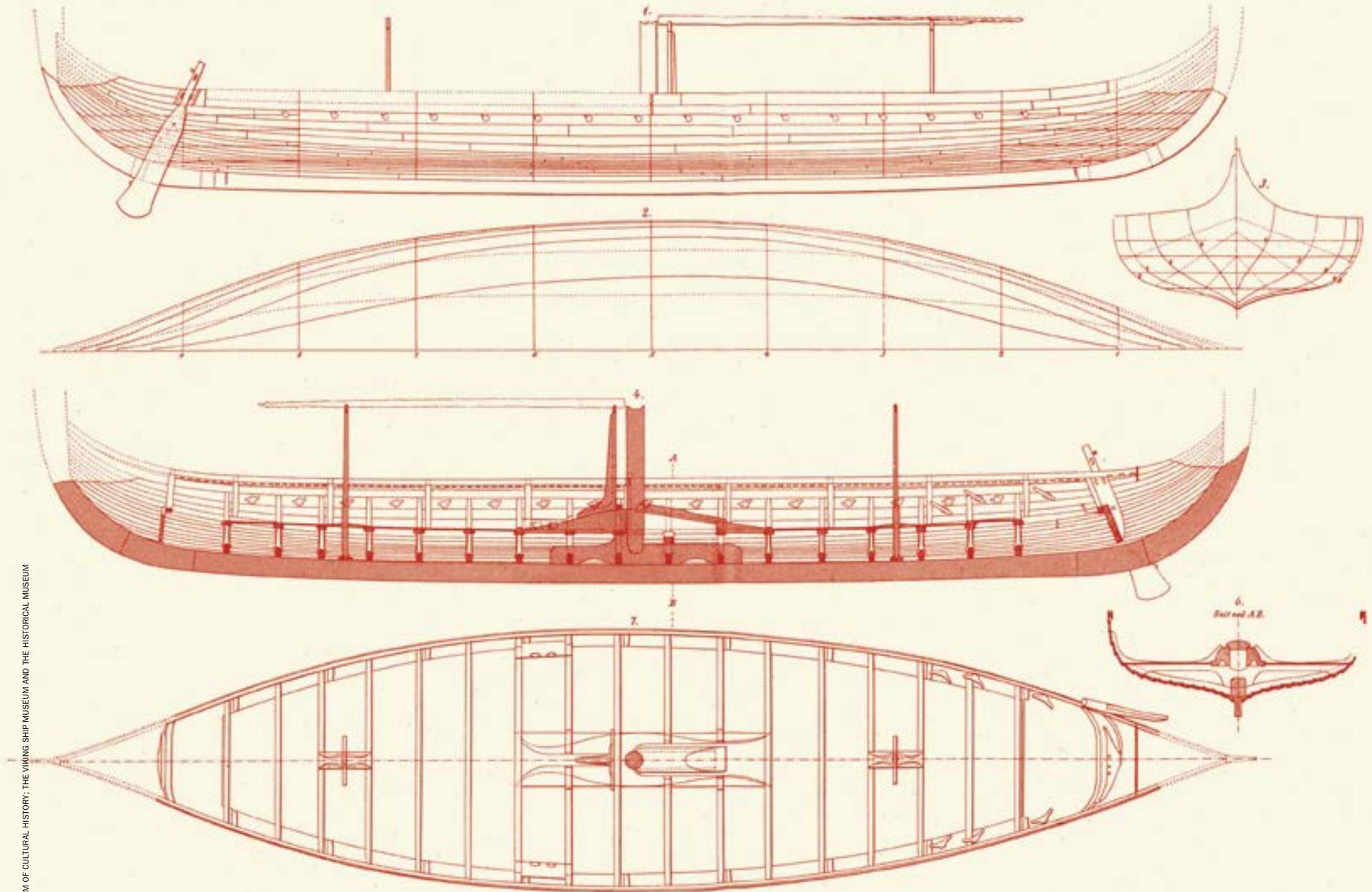
The Gokstad Viking ship, uncovered in 1879 and now restored in the Viking Ship Museum, in Oslo, Norway.



MUSEUM OF CULTURAL HISTORY; THE VIKING SHIP MUSEUM AND THE HISTORICAL MUSEUM

■ *At 75 feet in length with a beam of 16 feet, the*

vessel provides a remarkable glimpse back in time.



Gokstad Drawings from the book *Langskibet fra Gokstad ved Sandefjord* by Nicolay Nicolaysen.

It is difficult to overstate the importance of the Vikings in . . . global maritime history.

absence makes complete sense. Permanent benches would diminish deck space and add extra weight, both major liabilities when under sail in a seaway.

The oars were not uniform in length. Rather, they varied from 17 to 19 feet. You needed a shorter oar in the vessel's wider amidships section and a longer one at the pointy ends of the boat. Oars were constructed of pine and were exceedingly light. The design of the oar station is ingenious. Looking outboard from the deck, each oar hole has a notch cut out of the top left-hand section, where stress would be at a minimum during rowing. This arrangement allowed the crew to deploy the oars from inboard. They'd run the oars out when needed and pull them back in when sailing or beaching the boat.

It is difficult to overstate the importance of the Vikings in Scandinavian and global maritime history. The feats of the Norse are well known to most school children around the world. Using their skill as shipbuilders and sailors, the Vikings set forth in swift seaworthy vessels like the Gokstad ship, leaving their homeland, now present-day Norway, Denmark and Sweden, in search of riches and adventure. They raided and settled in parts of England, Ireland, France, Germany, Spain, Italy and Russia.

The appearance of a fleet of longships at the mouth of a harbor instilled terror in onlookers. The intricately carved dragonheads or snakeheads that typically topped the slender high bowposts, the rows of brightly painted shields hung on outboard racks along each side of the hull and the billowing woolen sails often decorated with colorful stripes all dazzled the eye while the fearsome reputation of the Norse as warriors could make even a brave man quake in his worn leather boots.

THE VIKINGS BUILT TWO TYPES OF SHIPS—THE LONGSHIP and the knarr. The longships were usually about 65 feet in length and were completely open to the elements. In a sense, they were simply overgrown rowboats equipped with sails. The knarrs were smaller, typically about 50 feet in length, and they were used as trading vessels. An enclosed hold allowed for carrying bulky cargo sheltered from rain and spray. The sail was the primary means of propulsion, and the crews were much smaller, usually no more than six mariners. In contrast, a longship carried more than 30 men.

To get an idea of just how innovative the design of a Viking ship was it's necessary to look at European sailing ships as a first step. European hull designs had what's known as bluff bows. Picture a barn door curved gently into a semicircle. It may strike some of us as counterintuitive to design a hull with a barn-door bow like that. A bluff bow resists the water; it doesn't cut like modern hull designs. European naval architecture evolved slowly over time.



The crew from the excavation of the Oseberg ship in 1904 at the Oseberg farm near Tønsberg, Norway.

In fact, sharp bows were largely an innovation of shipbuilder Donald McKay, the Canadian immigrant to the United States credited with pioneering the design of the American clipper ships that took to the seas in the late 1840s during the California Gold Rush. Prior to that, the bluff bow was the norm. If you flipped a typical square-rigged sailing ship upside down, you'd see that the profile of the underbody looked a little like a teardrop, with the rounded end of the drop at the bow and the pointy end at the stern.

IN ADDITION, EUROPEAN SAILING SHIPS WERE WIDE IN BEAM. Some had towering superstructures at the stern and bow. They had high freeboard, meaning the hulls above the waterline extended upward many feet. All of this caused excessive windage and added tons to overall displacement weights. They had deep holds, round bilges and deep drafts. The keels extended many feet down below the waterline. The keels provided plenty of lateral resistance to the pressure of the wind on the sails, reducing heel and enhancing tracking ability. In other words, the ship wouldn't lean over as much in a stiff breeze, and it wouldn't slip sideways much if the wind blew hard from abeam.

The Vikings didn't see a need for such ships. The slower knarr would

The photographs on this spread were taken at the excavation sites of the Gokstad ship (below and upper right) near Sandefjord in 1880 and the Oseberg ship (lower right) near Tønsberg in 1904.



MUSEUM OF CULTURAL HISTORY; THE VIKING SHIP MUSEUM AND THE HISTORICAL MUSEUM

| *The Vikings could beach the longships where no established harbors existed.*

suffice for trading. But a different sort of vessel was needed to forward Viking objectives. As the Norse population grew, available farmland became less easy to find. The people had to spread out and settle new lands as the Viking Age progressed. To do this required naval force and an ability to sail far on the open ocean without sinking. The Viking longship fit the bill brilliantly.

Longships featured sharp bows that could easily cut through the sea, thereby reducing resistance when motive force was applied to the hull either through sails or oars. One way the hull did this was that it sat mostly on top of the water like a duck. The cutwater didn't extend many feet below the waterline. As mentioned earlier, the concept of a sharp bow appears to have been lost on naval architects to the south. In this sense, the longship was centuries ahead of its time.

THERE WERE SEVERAL ADVANTAGES TO THE VIKING HULL design. First, the length at the waterline was close to the overall length of the vessel. In short, there were no excessive overhangs. The beautiful bows rose almost straight up from the cutwater. Longer waterlines relative to the length of the hull overall meant that the ships would have faster speed potential. The flared beam amidships added stability. The low freeboard and open deck with no superstructures created little windage, thereby reducing the tendency of the boat to slide sideways when the wind was abeam, and less structure saved weight too.

As noted, though, longships lacked the deep keels found on traditional square-riggers. This created problems because while there was little windage above the waterline to induce leeway there was also almost no lateral resistance below the waterline. A longship's draft was measured more in inches, not in many feet like traditional square-riggers. The shallow drafts allowed the ship's crew to sail or row up rivers where traditional European sailing vessels couldn't go, giving the Norse raiders a fantastic tactical advantage. The Vikings could beach the longships where no established harbors existed. The trade-off was you had to be a seriously seasoned sailor to handle the vessel properly when conditions got rough. Viking ships were not forgiving to novices. Lost ships and crews were common in the Viking Age.

Early in the Viking Age, oak was used almost exclusively, except to fabricate oars and deck planking. Some scholars estimate that as much as 2,000 cubic feet of oak was needed to build a 65-foot longship, or the equivalent of eleven oak tree trunks. As the availability of old-growth oak diminished in Scandinavia, more and more pine was used to build Viking longships. Pine is weak relative to oak. Late in the Viking Age, some evidence indicates that ships were actually pulled all the way out of the water and stored in

boatsheds to keep the hulls from worm infestation and general deterioration due to weather. Oak stood up better. But pine was all the Norse had to deal with during the latter part of the Viking Age, so they made the best of what timber they had on hand.

Norse longships were clinker built. The lower edge of each hull plank, or strake, overlapped the upper edge of the one below. This construction technique is also known as lapstrake. Three-inch iron rivets and round iron washers were used as fasteners. Wooden treenails that swelled up when wet were also used; these were preferred because they were stronger. A treenail was essentially a wooden dowel crafted to fit a bored hole like a bolt.

The strakes were attached to ribs that were in turn attached to a narrow keel running fore and aft down the centerline of the hull. The seams between strakes were stuffed with moss or animal hair coated in tar to create a watertight seal. The strakes were incredibly thin, at least to the modern eye. For example, the nine strakes below the waterline on the Gokstad ship are only 0.78 to 1.18 inches thick. Imagine having only a paper-thin layer between you and the sea while sailing in mid-ocean off Greenland. Imagine



Dragonhead prow from the Oseberg Viking ship.

When the seas got bad, bailing was part of daily life aboard a Viking longship.

if you hit a rock!

The clinker construction and the thinness of the strakes are yet two more reasons why the Viking longship worked so well. The clinker technique added strength and flexibility to the hull, and the thinness of the strakes greatly reduced weight. So did the lack of a superstructure. The crew had to endure life afloat in the wet and cold with soaked woolen blankets and crude sleeping bags, but no wooden cabins built on deck meant the boat would perform better when the chips were down in war and in foul weather.

The Viking shipbuilders spaced the rivets or treenails two feet apart to add even more flexibility to the hull. If the builders placed the rivets too closely together, the hull would become more rigid, almost like a wall. The Vikings didn't like that concept, whereas their European counterparts had no problem with it. Students of small-boat voyages know that the less resistance to the power of the sea you can present in your vessel, the better chances are that you'll survive a big storm. The Viking shipbuilders knew this intuitively.

In a seaway, such as off Greenland when the wind got up, the hulls would flex and bend when a heavy wave broke over the side. The force of the wave, which constituted many tons of pressure per square inch, would dissipate. Unfortunately, the inherent elasticity of the hull meant that the seams would open up in a rough seaway. When the seas got bad, bailing was part of daily life aboard a Viking longship. The pine decking was removable to allow for bailing, and for minimal storage.

BASED ON DIRECT OBSERVATIONS OF ROWERS ABOARD REPLICAS of Viking ships, it's possible to make an educated guess as to how fast these vessels were under oar power. It is thought that a crew could move a longship through the water at two knots. It's important to note that all-day stints at the oars would exhaust crews. The sail was the primary motive power for long-distance passages. The oars were ideal when raiding up shallow rivers. At short intervals, Viking ships could be rowed much faster than the typical two knots, but not for long.

As to sailing, there's a lot left to speculation. Starting with the basics, no sails have been found. That means scholars don't even really know what they looked like. Most replicas of Viking ships are fitted with sails with narrower and taller profiles than those seen on rune stones, coins and carvings. There is some debate as to whether the sails found on modern replicas were really shaped that way on Viking ships in the past. If the pictorial evidence from the Viking Age is to be believed, the sails were lower and broader. Others argue that the images of Viking ships on rune stones, coins and carvings are not in realistic proportion and therefore don't accurately depict the true shape of the sails.



The Oseberg Viking Ship at the Viking Ship Museum in Oslo, Norway.

The sagas say that the sails were made of wool. They were coated with animal fat and oils to keep them from rotting. Some carvings show an interlacing at the loose foot of a raised sail, which some scholars speculate was used to modify the shape of the sail to optimize sail trim, or to spill air in strong winds. A crosshatch pattern is seen on some depictions of sails, leading to speculation that the pattern was actually walrus hide sewn into the wool to add strength and preserve sail shape. This makes sense because wool would inevitably stretch out of shape even after a short period of hard use. Walrus hide woven into tight spirals was also used for running and standing rigging, as was hemp. The Vikings preferred Walrus hide because it was much tougher.

DESPITE A LACK OF PRECISE KNOWLEDGE ABOUT SAIL SHAPE and construction, we can apply common sense regarding the sailing abilities of a Viking ship. The lack of a deep keel to impart lateral resistance to side pressures from the wind and waves means the vessel would be subject to excessive beam leeway despite the lack of superstructures that would create windage. The wide beam amidships would provide initial stability, but the boat would still be subject to capsizing with the square sail up and braced for a strong beam wind. The low freeboard would make boarding waves common in a beam sea. In short, you'd have to be an expert to sail a

| *No evidence exists that Viking captains used charts, but sailing directions were available.*

Viking longship in a storm.

The best point of sail for a Viking ship was with the wind off the port or starboard quarter, or directly astern. If the wind was off the bow, the boat couldn't sail at all without drastically changing course to bring the wind aft. Square-sailed boats don't sail against the wind without the aid of fore-and-aft sails, like jibs or spankers, which the Viking ships didn't have.

The prevailing winds in the North Atlantic are westerly. Thus, Leif Ericson and all those who sailed before and after him faced the daunting prospect of trying to sail against the wind most of the way across the ocean. Crews couldn't row to keep position, at least not for long. They'd just burn themselves out, and the boat would go out of control. They'd have to run off with the wind astern. Because of the hull design, they couldn't take the waves from abeam if the seas were large. The ship would roll or fill up and sink. Running off would save them, but it would also lose them precious miles.

WHILE NO ONE KNOWS FOR SURE, IT'S INTERESTING TO speculate that the Vikings used a form of sea anchor. Think of a large walrus-hide bag with removable wooden or iron struts fixed across the opening to hold the bag open. You'd attach a line to the struts. If you threw the bag in the water and tied the other end of the line to the bow, the backward pressure of wind and waves against the hull would fill the bag and drastically reduce leeway astern. Even more important, the sea anchor would keep the bow into wind and waves, thereby greatly reducing the chance of broaching to (coming beam to wind and waves, and capsizing fast). It doesn't seem beyond the realm of imagination that the Vikings used some sort of sea anchors on long voyages of exploration. Indeed, it seems unimaginable that they didn't. Otherwise, progress west against the prevailing westerly winds would have been difficult, if not impossible, except in all but the calmest weather conditions.

On the upside, when the wind was abaft the beam (closer to the stern), sailing one of these ships with the square sail spread wide must have been like sailing a super-fast surfboard. Some operators of modern Viking ship replicas peg top speeds in excess of 20 knots. Given the hull design with its nearly flat underbody, such incredible speeds aren't beyond the scope of reality. Speeds of 12 knots are the most likely for most longships under sail.

No evidence exists that Viking captains used charts, but sailing directions were available. Captains sailing the 1,600 miles from Norway to Greenland departed the Norwegian coast at Hearnar, and set a course due west along that latitude, using the sun at local noon to estimate their position. They kept sailing until passing north of the Shetlands, which would be barely visible

over the horizon. They'd pass south of the Faeroe Islands. They used the mountains of the Faeroes as a landmark. The course would then take them far south of Iceland, beyond visible landmarks. The captains judged the ship's proximity to Iceland by the presence of seabirds, whales and even the wave patterns that would change because of the proximity of the big island.

There is debate as to whether the captains used a sort of sundial, or sunstone, to assist them in determining latitude. The device was a circular disc with a vertical rod protruding from the center of the disc. At noon, the sun would cast a shadow between two lines on the disc plate. The length of the shadow could be measured using scaling lines. With that information, the captain could set the course to stay on a constant line of latitude day after day. The line of position was acquired from crude estimates of the sun's zenith at local noon. In theory this would work, especially in high latitudes during the summer months, but there's no definitive way to know if Norse mariners actually did use sunstones.

What we do know is that the Vikings built and sailed ships that proved their superiority in trade, war, and long-distance exploration. These were vessels of beauty and utility, and they truly deserve a place of honor in maritime history. Their captains and crews remain exemplary in terms of bravery and seamanship in the early days of the Age of Exploration.



The Vikings typically made anchors of wood and stone.

PHOTO: WERNER FORMAN FROM ALAMY

David W. Shaw is a journalist, historian and avid sailor. He is the author of seven non-fiction books, including *Daring the Sea* (Citadel Press), *Flying Cloud* (HarperCollins) and *The Sea Shall Embrace Them* (Simon & Schuster). His work has appeared in countless magazines. He lives and sails with his wife, Liz, in South Carolina.