# Evaluation of Positioning Methods to Fix Navigational Obstructions


## Abstract

The navigational obstruction is a broad term used to describe the dangers that could face the mariners at the sea. These dangers are varied based on the cause, nature of the seabed, manmade installation, and the type and size of marine vehicle are used for transport and shipping at the sea. Generally, these danger and obstructions could be classified to two types' natural dangers and artificial dangers. The natural dangers could be due to the weather effects and water movement or type and depth of the seabed, where the artificial dangers include overhead cables, bridges, submerged cables, pipeline and under water human installation.

Marine navigation and shipping require accurate and precise data to move from one destination to another. Hydrographic survey data acquisition technology and positioning techniques have significantly advance over the last decade, where most of nautical products still rely on dated data and observation of mariner during their passage at the sea.

This paper mainly reviews some positioned navigational dangers observed during mariner passage using conventional methods such as lead line and radar navigation, which latter was found far away of their actual position when the hydrographic survey completed using modern technology.

Furthermore, evaluate positioning method of cover, uncover and submerged dangers and obstruction such as wreck, rock, islets, shoal (shallow) depths using recent hydrographic survey data and method of updating them based on notice to mariners, quality checks and their inclusion and presentation on the nautical products to enable safe navigation.

## Introduction

Since humanity has taken to the sea for hundreds of years, people have generally accepted that it is a dangerous profession. The sea is merciless, and there is no guarantee that a vessel and its members will return home safe and sound in times of turmoil. There might be accidents, bad weather, or other human events at the sea, which endanger the lives of the mariners (Brody 2021). However, in terms of obstructions on the seabed, at least, technology has come far. It is now possible to identify those dangers and adjust for them. Still, there seems to be a trend of non-usage of these technologies. Instead, vessels are using age-old technologies such as the lead line and radar system to this day. There remains no doubt that with modern technologies such as hydrographic survey, safety and security at sea can be increased manifold.

While navigating in the open sea, mariners are likely to face many problems and obstructions. However, how far a block is in danger would depend upon several factors, such as the nature of the sea bed, the heart of the obstruction, the type and size of the vehicle, etc. For that reason, while navigating, an accurate classification of the available blocks is crucial to the safety of the people on the vessel.

In documents submitted to the International Hydrographic Organisation, France and Australia have provided a broad categorization for identifying if something is a marine obstruction. In short, it has been described as 'anything that hinders or prevents movement' of a vessel. However, the document identifies that usually, obstructions would be taken more seriously if they cause danger or completely prevent the passage of a ship (International Hydrographic Organisation n.d.). Usually, the idea of obstruction applies to isolated obstructing elements rather than to rugged terrains in general.

However, another aspect described as 'Foul Ground' in this document would also fall under obstructions in everyday language. This refers to an area where a vessel can navigate, but it would be dangerous for anchoring, taking the ground, or fishing. The difference between obstruction and foul ground is, thus, the difficulty faced in surface navigation in case of obstruction (International Hydrographic Organisation n.d.).

In this context, in the twenty-first twenty-first-twenty-first century, when the human race can accurately navigate vessels in space and extraterrestrial objects, surely some obstruction in the seabed can pose no danger to the ship. These would be identified and notified to all the vessels nearby so they can alter their course accordingly and avoid that area. But the reality is more complex. To begin with, marine navigation still relies upon outdated technologies, which need more accuracy in these cases. Even though modern technologies for accurately identifying and mapping these dangers exist, they have yet to be implemented, and as a result, marine life remains a significant risk.

## Nature of Dangers

There are several kinds of dangers that mariners might face in the open sea, each one affecting the vessel and its members in a different way. The document provided by France and Australia has already categorized such dangers into obstructions and foul ground, but several other categorizations could be made. In the current context, broadly, they can be divided into two types – natural and artificial dangers. Natural dangers include shallow ground, water currents, bad weather, etc. (Raia 2009). On the other hand, artificial dangers in the seabed would consist of wrecks and other obstructions, overhead or submerged cables, bridges, pipelines, and underwater human installation.

These reasons, combined with the fact that a mariner at sea will likely be hundreds of miles away from human civilization and will not have the scope for asking for help in cases of emergencies, make working on a vessel one of the most dangerous professions. In several nations, governments have tried creating a map or publicly available database indicating the obstructions in seafaring. However, the available data is often inadequate, incomplete, and only available for the territorial waters. No such data is available for the open sea, where no nation has any rights.

In the US, the aspect of dangers is compounded because, as per the Oregon rule, if a ship or a vessel hits a stationary object on the seabed, the primary assumption would be that a boat does not hit a stationary object unless there have been any

problems in handling for the vessel. This was held in the Supreme Court case in 1985, popularly known as The Oregon case. While this assumption is not non-refutable, it leads to a strong belief in mishandling if a vessel in the sea hits an obstruction (Raia 2009). However, the reality is far more nuanced.

There are several situations where a vessel at sea might hit a stationary object without the ship being mishandled. As per the rule of The Oregon case, to prove their innocence, the ships' operators would first need to confirm that the crash was the fault of the stationery object and that the clash happened despite taking reasonable precautions. However, this is where the nuance of technological difficulty comes into play (Raia 2009). If the obstruction detection technology of the ship itself is faulty, and they get into an accident despite taking reasonable precautions, they would still be held liable as the fault could not be placed on the stationary object. Yet, the ship's staff could not have done anything to prevent it either.

## Need for Accurate Navigation

As the discussion above shows, many obstructions and dangers plague the seabed. As mariners, crew members on board a ship must consider these factors while navigating their vessels. Thus, having a navigation system that provides accurate results regarding the nature and extent of an obstruction is crucial. In particular, specific facets are necessary to be identified:

- Location of the obstruction, both the general area and the location concerning the traffic pattern of the vessel;
- Navigational difficulty around the obstruction, as that would further dictate the route of the ship;
- The depth of the water over the obstruction and fluctuations of the water level would determine whether sailing above the block is possible or not;
- The type of the vessel along with the density, as these details will also determine the possibility of sailing above.

- Characteristics of the obstruction – what kind of object it is, whether it is natural or artificial, and whether there is any movement of the block;
- Location of the obstruction concerning other obstructions and identifiers of navigation;
- Current and historic weather conditions;
- The length of time that the obstruction has been in place, any changes in characteristics happening within that time, and the history of incidents of other vessels involving such obstruction (Legal Information Institute n.d.);

Some details from these would be available in any potential navigation system, such as the location or the height. Other information might be made available by the domestic government or other governing bodies in that area, such as historical information and the history of accidents.

However, most, if not all, of these details help the vessel decide on an alternate course of movement if they detect an obstruction. Therefore, the currently used navigational techniques must accurately provide such data, creating significant danger and difficulty in navigation for the concerned vessels.

Thus, the idea remains that no matter how the possible obstructions are named or classified, they need to be accurately located and their nature identified to make navigation in the sea safer for all the crew members. Currently, conventional methods such as lead lines or radar identify obstructions. However, data from modern hydrographic surveys has shown that the data received from the traditional techniques needs to be more accurate and often misrepresents the obstruction's true nature. Therefore, relying upon such data would be highly dangerous for all involved.

## Current Inadequacies in Navigation

In this context, it is essential to take into account the navigational methods that are currently commonly used. As mentioned, even though there has been a plethora of

developments in marine technologies, many vessels use older technologies such as lead lines or radar-based navigation.

That is not to say there have been no developments in how vessels navigate. Starting from the medieval period, when the human race first began to venture into the vast open seas, there have been tremendous developments and modifications regarding how mariners navigate. Early navigation was based primarily on memorization of the routes, along with the motion of the stars and other celestial objects, weather, the size of waves, etc. (Ault 1926). All of these helped guide the sailors from one island to another. However, any long-form travel was almost impossible.

The first and most crucial development in marine navigation happened via the use of the astrolabe and the compass. This equipment allowed the mariners to accurately identify the direction of their sailing, ultimately leading to the Age of Discovery, with new shorelines being discovered worldwide (Ault 1926). In the twentieth century, these technologies further developed into aspects like gyro compass, radar technology, etc. The gyro compass is helpful in areas with a strong magnetic field. Unlike ordinary magnetic compasses, a gyro compass is not influenced by the external magnetic field and can still show true north. The radar system is far more advanced, and for navigators, it can identify aspects such as the ship's distance from the ground, any objects within the seabed, and other vessels and obstacles (Garvin 2010). A radar usually takes in the information in a 360-degree manner, so all aspects surrounding the ship are accurately mapped out.

The Orpheus ship was Grounding on Shuaiba Reef in 1979. In 1987, approximate position of the wreck was observed using a positional method of radar navigation. Based on survey in 2014, the wreck was found 1 km north-west of original observed location in 1987. Wreck is located in depth of 2 meters which differs from approximate observed position using radar (530 meters depth).

| | |
|---|---|
| **Name** | ORPHEUS |
| Type | M BULK CARRIER |
| Flag | Greek |
| Dimensions | Length = 178 m<br>Beam= 22.9 m<br>Draught= 13.4 m |
| Tonnage | 13,553 Gross |
| Cargo | Bulk Cement |
| Date Sunk | 17/06/1979 |

**Using Modern Technology**

However, in the twenty-first technology, the most accurate and efficient procedure that is available for navigation would be a hydrographic survey. A hydrographic survey charts out the seabed, shoreline, tides, currents, and obstructions and creates a detailed database for navigators to follow. Previously, it used to take a lot of work to conduct these surveys accurately. However, with advances in modern technology, automated drones and other such objects, satellite mapping, and the use of satellites, it is now possible to receive highly accurate data from hydrography (Paston 2011). The end process of a hydrographic survey would be to create a detailed map for sea navigation, which would be made available and valuable for the mariners.

Even though such effective technologies for the survey are now available, they still need to be more used, with many vessels still using older technologies such as the radar system. However, while the radar system was a crucial innovation, several factors considerably impacted its performance. To begin with, there is a practical limit to how far the radar can see, which will depend upon its transmitter and antenna. More importantly, the radar method could be more accurate for gauging the size of an object. Two objects of widely different sizes can appear the same on the radar, which measures not the actual size of the target but a cross-section of the same (Schleiss et al. 2020).

The inaccuracies depend on several external factors, including the shape and angle of the object in question. On the other hand, external noise from the sea, rain, snow, birds, or insects might hamper the readings and make them significantly cluttered. Interference can also arise from other radars or transmitters (Schleiss et al., 2020).

Compared to these aspects, the hydrographic survey is much more accurate because it uses various technologies and employs all of them to create a database for mariners. To make this extensive database, the hydrographic survey would use methods from the lead line to radars, echo sounding, lidar, autonomous and unmanned vehicles, satellites, etc. Several international and national organisations participate in hydrographic surveys, a behemoth task.

In terms of international organisations, the International Hydrographic Organisation is considered to be the primary policy-making body in this context. This is crucial because, for hydrographic data, similar standards for measurement, capturing, and updating must be followed globally. As this is data primarily about international waters that sailors of different nations will access, there must be uniform standards (MacMahan 2001). Several national governments, private organisations, and even crowdsourcing bodies work under the IHO to develop accurate nautical data to be used by all states. This data is mainly published by the Natiaonl Hydrographic Offices undersuppervission by IHO to be accessed by all.

Modern hydrographic surveys are, thus, capable of accurately identifying all covered, uncovered, and submerged dangers and obstructions, which include wrecks, rocks, islets, shoals, etc. Modern technologies primarily use inflatable crafts, autonomous and unmanned underwater vehicles, and remote-operated vehicles, which reach the desired area and depth and scan the relevant objects through various methods. If the details of the concerned thing are suspected not to be accurate, multiple measurement methods will be used to reach accurate data (Pastol 2011). The data is then sent through post-processing and updated by central software by creating a final output chart. This chart would then remain accessible to all. If changes are reported, the graph will be updated accordingly. Thus, crowdsourcing is also essential in this case, as the chart can be updated in real-time in a manner finds a mistake.

## Conclusion

Overall, there remains no doubt that marine navigation has come a long way in the last few centuries. Even when accurate measuring and navigation equipment and methods were unavailable, the mariners still explored new lands and waters. However, even though the twenty-first century provides many seamless navigation opportunities, most still need to be utilized.

The reason why the hydrographic survey is not extremely popular is twofold. On the one hand, using a hydrographic survey requires the cooperation of several stakeholders, many of whom are spread across different countries and continents. The national hydrographic organisations need to undertake accurate data and then share the same; the IHO needs to be at the masthead of the procedure; the private organisations and people need to report the data they collect accurately, and so on. Moreover, international collaboration and effort will be required for the open seas to finish the survey procedure. It is a humongous task involving unprecedented international cooperation. On the other hand, this collaboration is not happening because few vessels are using the hydrographic survey data, which can be attributed to the inadequacies of the existing data. Thus, the two reasonings are cyclically contributing to each other.

Thus, to break out of this cycle, cohesion of efforts will be required, both in the domestic and the international spheres. Increased efforts from the member nations, along with more individuals encouraging and using the procedure, are bound to bring the needed changes. This would require collaboration and cohesion not only at the international level, but on extremely individual levels as well. The nations would need to come forward and take their duties of hydrographic survey seriously, so that an accurate mapping system can be accessible for all. On the other hand, there needs to be a mechanism for crowdsourcing in this database, where the private organisations and individual sailors will contribute the data that they collect during their voyages. With such a coalition, most, if not all, of the seafloor will be mapped by survey in the near future.

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