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Ship Handling & Management Knowledge For MWS

موضوع:اطلاعیه فنی ۰۳-۲۰۱۸

دانش مدیریت و کنترل کشتی برای بازرس تضمین عملیات

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نسخه الکترونیکی اطلاعیه فنی مذکور در شبکه داخلی موسسه با آدرس ذیل قابل دسترسی می‌باشد:

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مدیر واحد کنوانسیون ها و مقررات دریایی
موسسه رده بندی ایرانیان

ترک دعوی: اگرچه در گردآوری کلیه راهنماهای فنی ارائه شده توسط موسسه رده بندی ایرانیان ،تا حد ممکن تلاش در دقت و صحت محتوا صورت گرفته است،این موسسه متحمل مسئولیتی در قبال هرگونه اشتباهات ،خسارت های احتمالی و جرائمی که ممکن است در ارتباط با بکار گیری مفاهیم و مطالب ارائه شده رخ دهد،نمیباشد.

موسسه رده بندی ایرانیان
نشانی دفتر مرکزی : تهران میدان هفت تیر ، خیابان قائم مقام فراهانی ،بالاتر از میدان شعاع ، کوچه شبنم

Ship Handling & Management Knowledge for Marine Warranty Surveyors:

It is impossible for any text, or other simulation to imagine that it could substitute for the practicalities of real time ship handling operations. Nothing can be a substitute for the real thing. However, the theory behind ship maneuvers can be explained but it is up to the practitioner to then take full account of the wind and tidal effects in a real-life situation.

Ship handling theory is a vast topic in its own right because not only are there numerous maneuvers but so many variants within those maneuvers (such as those effected by single right hand fixed propellers, twin screw vessels, ships with controllable pitch propellers, ships with tugs and without tugs, good weather or bad weather conditions prevailing, with tide or without tide, etc.).

The practitioner can take heart from the fact that the more handling and the more maneuvers that are attempted, the greater will be the expertise that is to be gained. It is hoped that this chapter will deal with the fundamentals of ship handling and provide theoretical principles of operation covering most of the more common situations.

Where modern hardware (like bow thruster/stern thrusters or controllable pitch propellers) are used, alternative maneuvers are easily employed; although it is appreciated that some vessels are fitted with only basic maneuvering aids.

Introduction to Marine Navigation

Marine navigation blends both science and art. A good navigator gathers information from every available source, evaluates this information, determines a fix, and compares that fix with his pre-determined “dead reckoning” position.

A navigator constantly evaluates the ship’s position, anticipates dangerous situations well before they arise, and always keeps “ahead of the vessel.” The modern navigator must also understand the basic concepts of the many navigation systems used today, evaluate their output’s accuracy, and arrive at the best possible navigational decisions.

Navigation methods and techniques vary with the type of vessel, the conditions, and the navigator’s experience.

Navigating a pleasure craft, for example, differs from navigating a container ship. Both differ from navigating a naval vessel. The navigator uses the methods and techniques best suited to the vessel and conditions at hand.

Some important elements of successful navigation cannot be acquired from any text or instructor. The science of navigation can be taught, but the art of navigation must be developed from experience.

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Types of Navigation

Methods of navigation have changed through history. Each new method has enhanced the mariner's ability to complete his voyage safely and expeditiously. One of the most important judgments the navigator must make involves choosing the best method to use. Commonly recognized types of navigation are listed below.

• Dead reckoning (DR) determines position by advancing a known position for courses and distances. A position so determined is called a dead reckoning (DR) position. It is generally accepted that only course and speed determine the DR position. Correcting the DR position for leeway, current effects, and steering error result in an estimated position (EP). An inertial navigator develops an extremely accurate EP.

• Piloting involves navigating in restricted waters with frequent determination of position relative to geographic and hydrographic features.

• Celestial navigation involves reducing celestial measurements to lines of position using tables, spherical trigonometry, and almanacs. It is used primarily as a backup to satellite and other electronic systems in the open ocean.

• Radio navigation uses radio waves to determine position by either radio direction finding systems or hyperbolic systems.

• Radar navigation uses radar to determine the distance from or bearing of objects whose position is known. This process is separate from radar's use as a collision avoidance system.

• Satellite navigation uses artificial earth satellites for determination of position. Electronic integrated bridge concepts are driving future navigation system planning. Integrated systems take inputs from various ship sensors, electronically display positioning information, and provide control signals required to maintain a vessel on a preset course. The navigator becomes a system manager, choosing system presets, interpreting system output, and monitoring vessel response.

In practice, a navigator synthesizes different methodologies into a single integrated system. He should never feel comfortable utilizing only one method when others are available for backup. Each method has advantages and disadvantages.

The navigator must choose methods appropriate to each particular situation. With the advent of automated position fixing and electronic charts, modern navigation is almost completely an electronic process. The mariner is constantly tempted to rely solely on electronic systems. This would be a mistake.

Electronic navigation systems are always subject to failure, and the professional mariner must never forget that the safety of his ship and crew may depend on skills that differ little from those practiced generations ago. Proficiency in conventional piloting and celestial navigation remains essential.

Phases of Navigation

Four distinct phases define the navigation process. The mariner should choose the system mix that meets the accuracy requirements of each phase.

- ✓ Inland Waterway Phase: Piloting in narrow canals, channels, rivers, and estuaries.
- ✓ Harbor/Harbor Approach Phase: Navigating to a harbor entrance and piloting in harbor approach channels.
- ✓ Coastal Phase: Navigating within 50 miles of the coast or inshore of the 200-meter depth contour.
- ✓ Ocean Phase: Navigating outside the coastal area in the open sea.

The navigator's position accuracy requirements, his fix interval, and his systems requirements differ in each phase. The following table can be used as a general guide for selecting the proper system(s).

	Inland Waterway	Harbor/Harbor Approach	Coastal	Ocean
DR	✓	✓	✓	✓
Piloting	✓	✓	✓	
Celestial			✓	✓
Radio		✓	✓	✓
Radar	✓	✓	✓	
Satellite	✓	✓	✓	✓

Navigational Terms and Conventions

The Earth

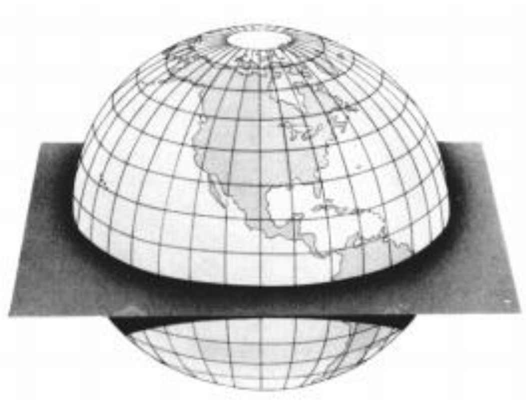
The earth is an oblate spheroid (a sphere flattened at the poles). Measurements of its dimensions and the amount of its flattening are subjects of geodesy. However, for most navigational purposes, assuming a spherical earth introduces insignificant error. The earth's axis of rotation is the line connecting the North Pole and the South Pole.

A great circle is the line of intersection of a sphere and a plane through its center. This is the largest circle that can be drawn on a sphere. The shortest line on the surface of a sphere between two points on the surface is part of a great circle. On the spheroidal earth the shortest line is called a geodesic. A great circle is a near enough approximation to a geodesic for most problems of navigation. A small circle is the line of intersection of a sphere and a plane which does not pass through the center.

The term meridian is usually applied to the upper branch of the half-circle from pole to pole which passes through a given point. The opposite half is called the lower branch.

A parallel or parallel of latitude is a circle on the surface of the earth parallel to the plane of the equator. It connects all points of equal latitude. The equator is a great circle at latitude 0°. See Figure 104b. The poles are single points at latitude 90°. All other parallels are small circles.

The planes of the meridians meet at the polar axis.



The equator is a great circle midway between the poles.

Coordinates

Coordinates, termed latitude and longitude, can define any position on earth. Latitude (L, lat.) is the angular distance from the equator, measured northward or southward along a meridian from 0° at the equator to 90° at the poles. It is designated north (N) or south (S) to indicate the direction of measurement.

The difference of latitude (l, DLat.) between two places is the angular length of arc of any meridian between their parallels. It is the numerical difference of the latitudes if the places are on the same side of the equator; it is the sum of the latitudes if the places are on opposite sides of the equator. It may be designated north (N) or south (S) when appropriate. The middle or mid-latitude (Lm) between two places on the same side of the equator is half the sum of their latitudes. Mid-latitude is labeled N or S to indicate whether it is north or south of the equator.

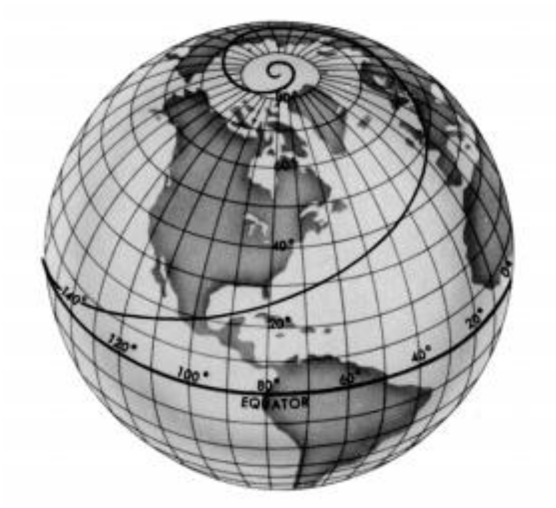
The expression may refer to the mid-latitude of two places on opposite sides of the equator. In this case, it is equal to half the difference between the two latitudes and takes the name of the place farthest from the equator. However, this usage is misleading because it lacks the significance usually associated with the expression. When the places are on opposite sides of the equator, two mid-latitudes are generally used. Calculate these two mid-latitudes by averaging each latitude and 0°.

Longitude (l, long.) is the angular distance between the prime meridian and the meridian of a point on the earth, measured eastward or westward from the prime meridian through 180°. It is designated east (E) or west (W) to indicate the direction of measurement.

The difference of longitude (DLo) between two places is the shorter arc of the parallel or the smaller angle at the pole between the meridians of the two places. If both places are on the same side (east or west) of Greenwich, DLo is the numerical difference of the longitudes of the two places; if on opposite sides, DLo is the numerical sum unless this exceeds 180°, when it is 360° minus the sum. The distance between two meridians at any parallel of latitude, expressed in distance units, usually nautical miles, is called departure (p, Dep.). It represents distance made good east or west as a craft proceeds from one point to another. Its numerical value between any two meridians decreases with increased latitude, while DLo is numerically the same at any latitude. Either DLo or p may be designated east (E) or west (W) when appropriate.

Distance On the Earth

Distance, as used by the navigator, is the length of the rhumb line connecting two places. This is a line making the same angle with all meridians. Meridians and parallels which also maintain constant true directions may be considered special cases of the rhumb line. Any other rhumb line spirals toward the pole, forming a loxodromic curve or loxodrome. Distance along the great circle connecting two points is customarily designated great-circle distance. For most purposes, considering the nautical mile the length of one minute of latitude introduces no significant error.



A loxodrome

Speed (S) is rate of motion, or distance per unit of time. A knot (kn.), the unit of speed commonly used in navigation, is a rate of 1 nautical mile per hour. The expression speed of advance (SOA) is used to indicate the speed to be made along the intended track. Speed over the ground (SOG) is the actual speed of the vessel over the surface of the earth at any given time. To calculate speed made good (SMG) between two positions, divide the distance between the two positions by the time elapsed between the two positions.

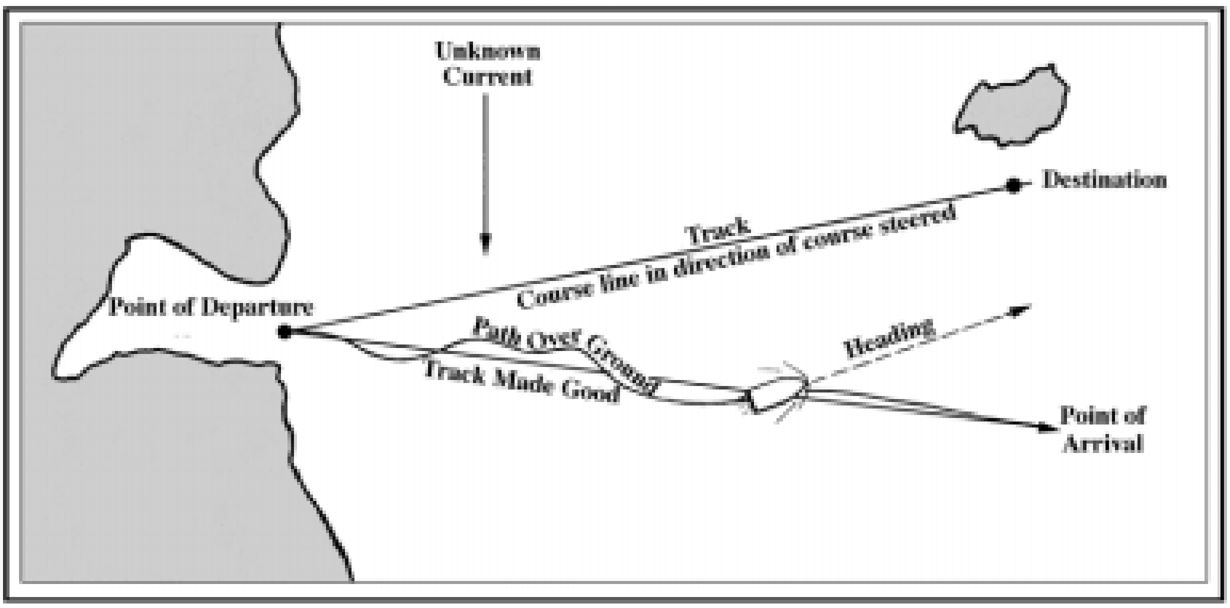
Direction On the Earth

Direction is the position of one-point relative to another. Navigators express direction as the angular difference in degrees from a reference direction, usually north or the ship's head. Course (C, Cn) is the horizontal direction in which a vessel is steered or intended to be steered, expressed as angular distance from north clockwise through 360°. Strictly used, the term applies to direction through the water, not the direction intended to be made good over the ground.

The course is often designated as true, magnetic, compass, or grid according to the reference direction. Track made good (TMG) is the single resultant direction from the point of departure to point of arrival at any given time.

Course of advance (COA) is the direction intended to be made good over the ground, and course over ground (COG) is the direction between a vessel's last fix and an EP. A course line is a line drawn on a chart extending in the direction of a course. It is sometimes convenient to express a course as an angle from either north or south, through 90° or 180°. In this case it is designated course angle (C) and should be properly labeled to indicate the origin (prefix) and direction of measurement (suffix).

Thus, C N35°E = Cn 035° (000° + 35°), C N155°W = Cn 205° (360° - 155°), C S47°E = Cn 133° (180° - 47°). But Cn 260° may be either C N100°W or C S80°W, depending upon the conditions of the problem.



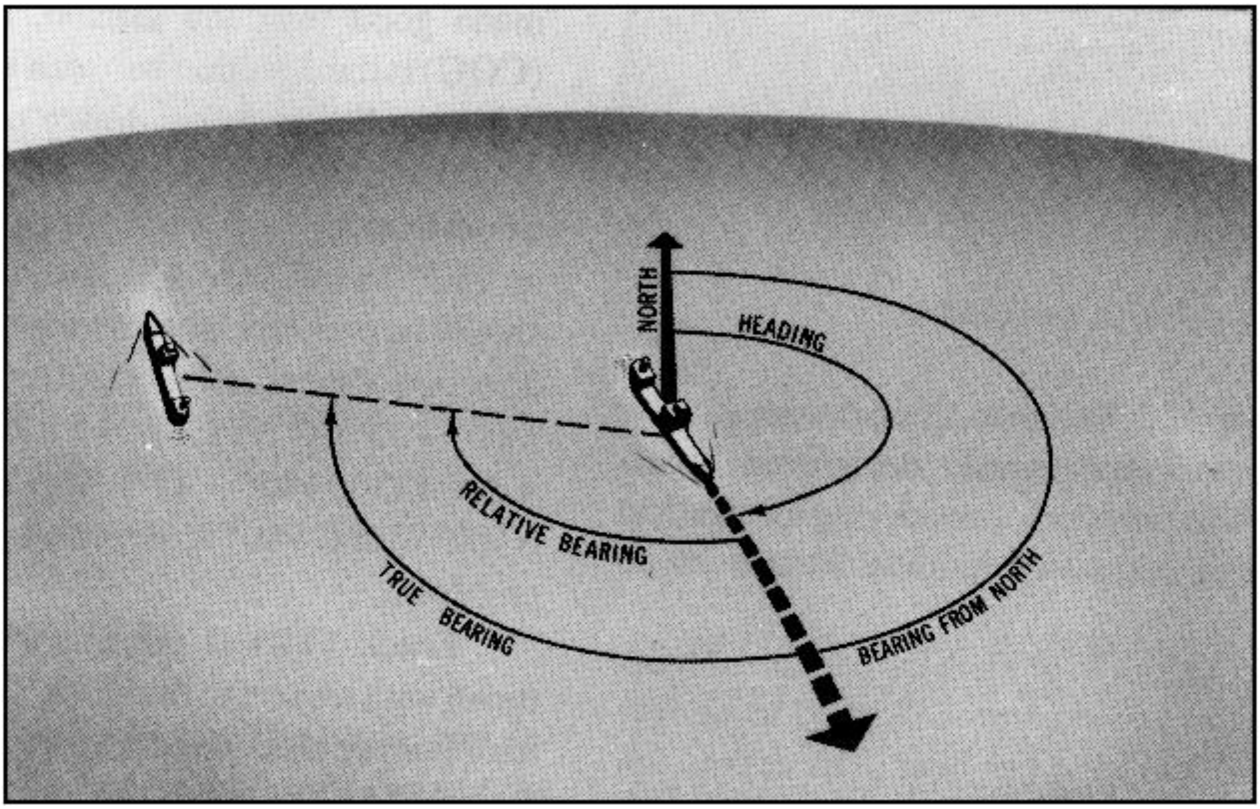
Course line, track, track made good, and heading.

Track (TR) is the intended horizontal direction of travel with respect to the earth. The terms intended track and trackline are used to indicate the path of intended travel.

The track consists of one or a series of course lines, from the point of departure to the destination, along which it is intended to proceed. A great circle which a vessel intends to follow is called a great-circle track, though it consists of a series of straight lines approximating a great circle.

Heading (Hdg., SH) is the direction in which a vessel is pointed, expressed as angular distance from 000° clockwise through 360°. Do not confuse heading and course.

Heading constantly changes as a vessel yaws back and forth across the course due to sea, wind, and steering error.



Relative Bearing.

Bearing (B, Brg.) is the direction of one terrestrial point from another, expressed as angular distance from 000° (North) clockwise through 360°. When measured through 90° or 180° from either north or south, it is called bearing angle (B). Bearing and azimuth are sometimes used interchangeably, but the latter more accurately refers to the horizontal direction of a point on the celestial sphere from a point on the earth. A relative bearing is measured relative to the ship's heading from 000° (dead ahead) clockwise through 360°. However, it is sometimes conveniently measured right or left from 0° at the ship's head through 180°.

This is particularly true when using the table for Distance of an Object by Two Bearings. To convert a relative bearing to a true bearing, add the true heading:

- ✓ True Bearing = Relative Bearing + True Heading.
- ✓ Relative Bearing = True Bearing – True Heading.

Development of Navigation

Latitude and Longitude Determination

Navigators have made latitude observations for thousands of years. Accurate sun declination tables have been published for centuries, enabling experienced seamen to compute latitude to within 1 or 2 degrees. Mariners still use meridian observations of the sun and highly refined ex-meridian techniques. Those who today determine their latitude by measuring the altitude of Polaris are using a method well known to 15th century navigators.

A method of finding longitude eluded mariners for centuries. Several solutions independent of time proved too cumbersome. The lunar distance method, which determines GMT by observing the moon's position among the stars, became popular in the 1800s. However, the mathematics required by most of these processes were far above the abilities of the average seaman. It was apparent that the solution lay in keeping accurate time at sea.

In 1714, the British Board of Longitude was formed, offering a small fortune in reward to anyone who could provide a solution to the problem.

An Englishman, John Harrison, responded to the challenge, developing four chronometers between 1735 and 1760. The most accurate of these timepieces lost only 15 seconds on a 156 day round trip between London and Barbados.

The Board, however, paid him only half the promised reward. The King finally intervened on Harrison's behalf, and Harrison received his full reward of £20,000 at the advanced age of 80.

Rapid chronometer development led to the problem of determining chronometer error aboard ship. Time balls, large black spheres mounted in port in prominent locations, were dropped at the stroke of noon, enabling any ship in harbor which could see the ball to determine chronometer error. By the end of the U.S. Civil War, telegraph signals were being used to key time balls. Use of radio signals to send time ticks to ships well offshore began in 1904, and soon worldwide signals were available.

The Navigational Triangle

Modern celestial navigators reduce their celestial observations by solving a navigational triangle whose points are the elevated pole, the celestial body, and the zenith of the observer.

The sides of this triangle are the polar distance of the body (codeclination), its zenith distance (coaltitude), and the polar distance of the zenith (colatitude of the observer).

A spherical triangle was first used at sea in solving lunar distance problems. Simultaneous observations were made of the altitudes of the moon and the sun or a star near the ecliptic and the angular distance between the moon and the other body. The zenith of the observer and the two celestial bodies formed the vertices of a triangle whose sides were the two coaltitudes and the angular distance between the bodies. Using a mathematical calculation the navigator “cleared” this distance of the effects of refraction and parallax applicable to each altitude. This corrected value was then used as an argument for entering the almanac. The almanac gave the true lunar distance from the sun and several stars at 3 hour intervals.

Previously, the navigator had set his watch or checked its error and rate with the local mean time determined by celestial observations. The local mean time of the watch, properly corrected, applied to the Greenwich mean time obtained from the lunar distance observation, gave the longitude.

The calculations involved were tedious. Few mariners could solve the triangle until Nathaniel Bowditch published his simplified method in 1802 in The New American Practical Navigator.

Reliable chronometers were available in 1802, but their high cost precluded their general use aboard most ships.

However, most navigators could determine their longitude using Bowditch’s method. This eliminated the need for parallel sailing and the lost time associated with it. Tables for the lunar distance solution were carried in the American nautical almanac until the second decade of the 20th century.

Navigational Tables

Spherical trigonometry is the basis for solving every navigational triangle, and until about 80 years ago the navigator had no choice but to solve each triangle by tedious, manual computations.

Lord Kelvin, generally considered the father of modern navigational methods, expressed interest in a book of tables with which a navigator could avoid tedious trigonometric solutions.

However, solving the many thousands of triangles involved would have made the project too costly. Computers finally provided a practical means of preparing tables. In 1936 the first volume of Pub. No. 214 was made available; later, Pub. No. 249 was provided for air navigators. Pub. No. 229, Sight Reduction Tables for Marine Navigation, has replaced Pub. No. 214.

Modern calculators are gradually replacing the tables. Scientific calculators with trigonometric functions can easily solve the navigational triangle. Navigational calculators readily solve celestial sights and perform a variety of voyage planning functions. Using a calculator generally gives more accurate lines of position because it eliminates the rounding errors inherent in tabular inspection and interpolation.

Electronics and Navigation

Perhaps the first application of electronics to navigation involved sending telegraphic time signals in 1865 to check chronometer error. Transmitting radio time signals for at sea chronometer checks dates to 1904.

Radio broadcasts providing navigational warnings, begun in 1907 by the U.S. Navy Hydrographic Office, helped increase the safety of navigation at sea.

By the latter part of World War I the directional properties of a loop antenna were successfully used in the radio direction finder. The first radiobeacon was installed in 1921. Early 20th century experiments by Behm and Langevin led to the U.S. Navy's development of the first practical echo sounder in 1922.

Today, electronics touches almost every aspect of navigation. Hyperbolic systems, satellite systems, and electronic charts all require an increasingly sophisticated electronics suite. These systems' accuracy and ease of use make them invaluable assets to the navigator. Indeed, it is no exaggeration to state that, with the advent of the electronic chart and differential GPS, the mariner will soon be able to navigate from port to port using electronic navigation equipment alone.

Development of Radar

As early as 1904, German engineers were experimenting with reflected radio waves. In 1922 two American scientists, Dr. A. Hoyt Taylor and Leo C. Young, testing a communication system at the Naval Aircraft Radio Laboratory, noted fluctuations in the signals when ships passed between stations on opposite sides of the Potomac River. In 1935 the British began work on radar. In 1937 the USS Leary tested the first seagoing radar. In 1940 United States and British scientists combined their efforts. When the British revealed the principle of the multicavity magnetron developed by J. T. Randall and H.

A. H. Boot at the University of Birmingham in 1939, microwave radar became practical. In 1945, at the close of World War II, radar became available for commercial use.

Development of Hyperbolic Radio Aids

Various hyperbolic systems were developed from World War II, including Loran A. This was replaced by the more accurate Loran C system in use today. Using very low frequencies, the Omega navigation system provides worldwide, though less accurate, coverage for a variety of applications including marine navigation. Various short range and regional hyperbolic systems have been developed by private industry for hydrographic surveying, offshore facilities positioning, and general navigation.

Other Electronic Systems

The Navy Navigation Satellite System (NAVSAT) fulfilled a requirement established by the Chief of Naval Operations for an accurate worldwide navigation system for all naval surface vessels, aircraft, and submarines. The system was conceived and developed by the Applied Physics Laboratory of The Johns Hopkins University. The underlying concept that led to development of satellite navigation dates to 1957 and the first launch of an artificial satellite into orbit.

NAVSAT has been replaced by the far more accurate and widely available Global Positioning System (GPS).

The first inertial navigation system was developed in 1942 for use in the V2 missile by the Peenemunde group under the leadership of Dr. Wernher von Braun. This system used two 2-degree-of-freedom gyroscopes and an integrating accelerometer to determine the missile velocity. By the end of World War II, the Peenemunde group had developed a stable platform with three single-degree-of-freedom gyroscopes and an integrating accelerometer. In 1958 an inertial navigation system was used to navigate the USS Nautilus under the ice to the North Pole.