DOWNLOAD PDF DETERMINATION OF THE LONGITUDE OF VALENTIA IN IRELAND BY TRANSMISSION OF CHRONOMETERS

Chapter 1 : History of timekeeping devices - The Full Wiki

Determination of the longitude of Valentia in Ireland by transmission of chronometers. LONGITUDE: Comment.

Mention of Bidston Hill conjures up, for me, fond memories of long childhood hours spent playing in its woods, picnicking on its springy turf, and hiding in its secret places. And always, the feeling that this was no ordinary place. And indeed few other parts of Wirral can offer so much of interest in such a small area. Where else in a few hundred acres can you find open, gorse-covered heathland with fine land and sea views, pine woods and rhododendrons, a lighthouse, an observatory, a windmill, rock carvings, and a fascinating seventeenth century village? And Harry Neilson wrote: I distinctly remember a walk over Bidston Hill when a child with an elder sister, about the year A fresh breeze was blowing and the sails of the mill were turning round in full swing, grinding corn. A cart, laden with sacks of flour, stood just ready to leave by the stony cart track to the road below while the miller stood by chatting to the carter. As we stood watching, the loaded cart moved off and the miller asked us if we would care to look inside the mill. His invitation was gladly accepted and in we went. My first and lasting impression was of the loud buzzing noise of the machinery, very like the sound of a swarm of angry bees but much louder, and my next, the whiteness of everything inside the mill, caused by the coating of fine white flour dust which nothing could escape, not even the miller himself. A telegraph service was set up to give early notice of the arrival of ships in the Port of Liverpool. Over one hundred signalling poles were erected, extending from north of the lighthouse to beyond the windmill, belonging mainly to the merchants in Liverpool. As the ships carrying their cargoes were spotted out to sea, the relevant flags were raised and could be spotted from Liverpool. It took only eight minutes to transmit messages from Holyhead to Liverpool. Mariners also had no knowledge of weather conditions when they left port and consequently sometimes ran into storms. This was achieved when the difference in longitude between Greenwich and Valentia, Ireland, was calculated, in conjunction with two intermediate stations, one of which was Liverpool Observatory. This was determined by observing the stars with the transit telescope, thus calculating Greenwich Mean Time. A daily signal was given at l pm by the release of a time ball. Accuracy was achieved by setting up chambers with regulated temperatures in which to carry out tests. These telescopes are now in Liverpool Museum. There was a large instrument room - the through room on the ground floor â€" which contained two warm air chambers. Each of these could hold up to one hundred chronometers which were tested over several months at varying temperatures and had to be very accurate before they were considered safe to take to sea. Sextants, barometers and thermometers were tested in the basement. This was situated at Morpeth Dock, Birkenhead and was connected by telegraphic line to Bidston Observatory. It was fired from here by the staff each working day, except for a six year break during the Second World War. It was also fired at midnight to mark the beginning of the 20th century. The original cannon was a relic of the Crimean wars, and after it was replaced by a naval Hotchkiss gun, was on display in the Observatory grounds for many years. Tidal predictions, which were calculated by hand, were produced on a commercial basis. Two tide predicting machines were now in use, and the tidal expertise of the institute received worldwide acclaim. Weather forecasting at Bidston ceased, although observations continue to be made to the present day. The staff worked seven days a week, from early morning to late at night, analysing and predicting tides towards the war effort. Tidal predictions were swiftly predicted for the seas around Burma, France and Holland. During these years one of the tide predicting machines was placed in an underground room in the Observatory grounds for security reasons. Photographic facilities were obtained, so that further copies of the predictions could be quickly provided in the event of their loss at sea. Windmill gets a new roof. Proudman Institute building demolished. This history was published by the Centre for coastal and Marine Sciences. Metal shapes were raised on the poles corresponding to the number of vessels in sight according to their rig. A flag was flown when the number exceeded three. From the lighthouse the poles indicated in order: The pole at an oblique angle on the end of the building was used to indicate a vessel in distress in the Rock Channel by means of flying a flag at half-mast. Flag sheets illustrating the lighthouse and its signals together with a key were published from about until the s, when the semaphore below had established itself. The lighthouse and signals also appear on items of Liverpool pottery of the same period. In Bidston Lighthouse had a female lighthouse keeper. In or , the Bidston Lighthouse was demolished and rebuilt and a temporary light operated from the roof of the Telegraph Office. The light on the second Bidston Lighthouse stopped working on 9 October From a Signal Station was located on the Hill eventually consisting of over flagpoles sited all along the ridge of the Hill. Mostly used to send messages to the merchants of Liverpool of incoming ships, some were also used to warn of enemy warships and ships in distress. The most visible hole that remains is approximately 30 yards north of the Windmill. In the first lighthouse was built, it replaced Lower Mockbeggar light, which collapsed on Moreton foreshore. An octagonal building, it formed part of the chain of semaphore signals along the N. A message could be sent from Holyhead to Liverpool in 8 minutes!

Chapter 2 : George Biddell Airy | Open Library

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Christopher Wren designed the present east and south wings, and the Fountain Court. The famous maze was planted c. In , it was reported that the replanting with English yew in the s was done with the plants too close together and so the trees did not produce lateral growth, leaving gaps which have had to be filled with railings or stakes. Possibly the whole maze will have to be replanted. The prime meridian ran through here before Greenwich. In the Old Deer Park are three obelisks, to the east, west and north, used as meridian marks for adjusting the instruments. He was followed, from to , by his son Stephen G. Demainbray , assisted by his brother-in-law Stephen Rigaud, who died in Stephen Peter Rigaud , the son of Stephen Rigaud and Mary Demainbray, was Savilian professor of geometry, then astronomy, at Oxford; he succeeded his father as Observer in until his death in Demainbray brought his collection of instruments to Kew and they were incorporated with the royal collection of instruments bought by George III in from George Adams, as well as instruments of previous kings. It did not perform well, but the King remembered he had stored lodestones nearby! It ceased as an astronomical observatory in , but continued as a magnetic and meteorological observatory until the early s. Francis Ronalds was Director in In , Warren De La Rue set up his photoheliograph here and began the first daily recording of sunspots. It is of especial interest to those of an astronomical or navigational inclination. It was founded on 22 Jun by Charles II who commanded Flamsteed to apply "the most exact Care and Diligence to rectifying the Tables of the Motions of the Heavens, and the Places of the fixed Stars, so as to find out the so-much desired Longitude at Sea, for perfecting the art of Navigation". This was essentially the method of lunar distances, first proposed by Johannes Werner in The commission asked Flamsteed to report on it and he showed the method was theoretically sound, but was impractical as the positions of the moon and the stars were not known with sufficient accuracy. Jonas Moore, governor of the Tower, Surveyor General of the Ordnance, instigated the foundation of an observatory and actually donated the necessary instruments to Flamsteed. Hooke directed the construction. The foundation stone was laid on 10 Aug and the first observations from it were made on 31 May Several Astronomers Royal are of interest to mathematicians and the others are of some historical importance even if not of mathematical interest, so I will list them dates are of tenure of the post. He was the first astronomer to make regular use of telescopic sights. He also invented the conical projection for maps. His assistant, Joseph Crosthwait, prepared his observations for publication after his death. Edmond Halley , whose tombstone is in the courtyard. He continued as Savilian professor of geometry at Oxford while being Astronomer Royal. This instrument may still be at the observatory. He also continued as Savilian professor of astronomy at Oxford. He favoured the method of lunar distances. He founded the Nautical Almanac in He determined the universal gravitational constant G in v. Maskelyne installed the first transit telescope, on the present Prime Meridian. With this and new clocks, it was believed that observations could be made accurate to 0. However Maskelyne discovered that he and his assistant Kinnebrooke differed by an average of 0. John Pond , who was requested to resign. George Biddell Airy Glaisher both declined the post. William Henry Mahoney Christie Chief Assistant from Frank Watson Dyson Eddington was a prominent member of the expedition. Sydney Chapman was an assistant. Harold Spencer Jones He used observations of Eros to determine accurately the distance of the Earth from the sun. Francis Graham Smith From , the roles of Astronomer Royal and Director of the Royal Greenwich Observatory, then at Herstmonceux, were separated and the Directors have been the following. Margaret Burbidge Alan Hunter Some other notable persons and events connected with the Observatory are the following. Abraham Sharp lived with Flamsteed in and was his assistant in In , he computed pi to 75 places. In , John Harrison came to see Halley here. John Hellins was an assistant in the late 18C. Llanberis, Newsletter 38 p. He was a pioneering meteorologist and made numerous ascents in balloons to make observations, reaching 30, feet without oxygen in , a record that still stands. Walter Maunder was Superintendent of the Physical Department, c. He announced the eleven year cycle of sunspots in Philip Cowell was Chief Assistant from to c. They were able to extrapolate backward and identify all its appearances back to Eddington , was Chief Assistant In , Melotte discovered the 8th moon of Jupiter. The Observatory removed to Herstmonceux Castle, Sussex , in , due to smoke and light pollution obscuring the viewing, as well as air pollution attacking the instruments. Herstmonceux is a minute or so two off the Prime Meridian. The Greenwich buildings were turned over to the National Maritime Museum as the observatory moved out. Some departments had already had to move in the s, e. When this happened the London site dropped the "Old" from its title. The Prime Meridian crosses the Observatory courtyard. Outside is a 24 hour Shepherd slave clock installed by Airy in , part of the system that provided time signals by telegraphy. Beneath it are standards of length, a reminder that the original standards were burnt in the Houses of Parliament in and had to be re-established. Note the fine views. Entering the Observatory courtyard, you cross the Meridian, marked by a lighted strip. The present Meridian was internationally adopted by a conference in Washington in A report says that a laser beam now projects along it to Essex, but looking through a telescope provided, one sees that a recent building is obstructing the view to the Essex skyline! There were earlier meridians through earlier instruments. From to , it was 19 feet west of the present one. There is an obelisk on Pole Hill, Epping Forest, Chingford, Essex, used for aligning the instrument, but in it had long been invisible. A letter to The Times from Paul A. I visited Pole Hill in and can confirm that the obelisk is difficult to find and there is hardly any view. From to c. The Meridian has been marked a few other places, e. The ticket counter is in a lobby, where there is a bust of Halley and some instruments, including a astrolabe. Flamsteed built this room for this purpose. A leaflet is available near the ticket counter. Back in the courtyard, enter an annex to Flamsteed House. The first two rooms have material on Flamsteed, Greenwich and the longitude problem. This is one of the few Wren interiors extant, now restored to its original form. There are three replicas of the one-year clocks made by Thomas Tompion in which Flamsteed used to check the constancy of the day: One of the originals is in the British Museum. The other was recently located at Holkham Hall, Norfolk, and bought for the Observatory where it is now on display, though it had been much modified for use as a domestic clock. From the Octagon Room, one descends to an exhibition on time-keeping and longitude. The background to this is the disaster when on the night of 22 Oct , Sir Clowdisley Shovell ran his HMS Association and three other ships aground on the Gilstone Ledges off the Scilly Isles, losing about lives, including his own. This is usually ascribed to his not knowing his longitude. In fact the consensus among his captains was that they were near Ushant at the south entrance to the English Channel, whereas they were approaching the Scillies, about miles north-northwest of Ushant. Thus, the error was more one of latitude than of longitude. At the beginning of this room is material about the longitude problem: The room opens into a larger section. Here are the most notable items of the entire Museum, the original marine chronometers of John Harrison , which solved the problem of longitude. The central cases contain H1 , H2 , H3 and H4 the first small chronometer of which is the most important watch ever made. H4 lost only five seconds in an 81 day voyage to Jamaica in and when William Harrison predicted landfall at Madeira within a day, Captain Digges was incredulous and bet it would not occur. When it did, Digges offered to buy a chronometer as soon as one became available and presented William and the absent John with an octant, now on display in this room.

Chapter 3 : Determination of the longitude of Valentia in Ireland by transmission of chronometers. - CORE

Determination of the longitude of Valentia in Ireland by transmission of chronometers. By George Biddell Airy. Abstract. Mode of access: Internet.

In each of these countries their distinctive style was further developed until the end of the century where the exchange between the two countries increased and gave rise to a more uniform style of big, flat watches. Later a few centres developed, in which high quality watches were produced, especially for the Ottoman and Chinese market. In England the watches kept the single footed cock, but the D- shape of the cock-foot seen at the end of the 17th century was retained only until about Starting from then, the foot got narrower and the diameter of the cock itself diminished. The English retained their rear winding system throughout, but added consequently a dust cap for protection as soon as the cylinder escapement was introduced. Silver and gold as material for dials got replaced by enamelled copper. One of the most important English contributions to gaining precision in timekeeping in the early 18th century was made by George Graham, who perfected the cylinder escapement. Thanks to his refinements watches could be of thinner construction and of smaller size. The cases remained rather plain, with occasional engravings such as coat of arms at the beginning of the century. From left to right: During the s Thomas Mudge developed the lever escapement and in parallel the Longitude problem was tackled by several watchmakers, inspiring John Harrison to develop one of the most famed watches in history: John Arnold and Thomas Earnshaw disputing over the privileges of perfecting escapes and compensation balances and building marine chronometers, some of which accompanied the most important geographical expeditions of the 18th century. Andrew Dunlop, London, No. Featuring tulip pillars, lacking, motion work, dial and hands. Andrew Dunlop is recorded as working between and He was the maker of the turret clock for Hawkley House, Blackwater in , and is also known as a maker of watches and long-case clocks. Conyers Dunlop was apprenticed to him in Unification of Great Britain The political union that joined the kingdoms of England and Scotland happened in during the reign of Queen Anne, when the Acts of Union ratified the Treaty of Union and merged the parliaments of the two nations, forming the Kingdom of Great Britain, which covered the entire island. Prior to this, a personal union had existed between these two countries since the Union of the Crowns under James VI of Scotland and I of England. The Acts of Union declared that: In , the union was heraldically expressed by the impalement, or placing side-by-side in the same quarter, of the arms of England and Scotland, which had previously been in different quarters. In Scotland, a separate form of arms was used on seals until the Act of Union. Later before almost perfect, white enamelled copper dial. Of course the size of this cock does not permit to show all the details of the central part of the Arms where the quadrants are. This movement could have been made as commemorative piece either for the unification in or for Queen Anne, after her death in Older commemorative watches are known bearing the Royal coat of arms to commemorate the death of William III in One example in the British Museum , It is very unlikely that this movement and others like it were made for the Royal household as a gift to others, as the quality of the manufacture is not as elevated as one would expect for a Royal order. Ex private collection Lille F Robert Simkins, apprentice of John Beeckmann was freed of the clockmakers company the 2. He apprenticed 4 watchmakers between and She continued to reign as Queen of Great Britain and Ireland until her death. Anne was born in the reign of her uncle Charles II, who had no legitimate children. Her father, James, was first in line to the throne. William and Mary had no children. As queen, Anne favoured moderate Tory politicians, who were more likely to share her Anglican religious views than their opponents, the Whigs. The Whigs grew more powerful during the course of the War of the Spanish Succession, until in Anne dismissed many of them from office. Her close friendship with Sarah Churchill, Duchess of Marlborough turned sour as the result of political differences. Anne was plagued by ill health throughout her life. From her 30s onwards, she grew increasingly lame and obese. Despite seventeen pregnancies by her husband, Prince George of Denmark, she died without any surviving children and was the last monarch of the House of Stuart.

Under the terms of the Act of Settlement , she was succeeded by her second cousin George I of the House of Hanover, who was a descendant of the Stuarts through his maternal grandmother, Elizabeth, daughter of James VI and I. Queen Anne died at around 7: This together with the outstanding skills of the workmen he employed gave him an unrivalled reputation throughout the known world. Law imposed that not more than 2 apprentices at once can be instructed 2. Because of the high social status of Tompion he managed to circumvent this law 2. Certainly from around it was George Graham who was in partnership with Tompion, some of his later productions are jointly signed, and mysteriously some clocks have this signature on a separate plate which overlays that of Tompion and Banger engraved on the dial plate. Some watches with a joined signature of Tompion and George Graham are known, starting from , after Tompions death Graham signed the watches with his own name and continued Tompions production numbering. Featuring Egyptian pillars, lacking, motion work, dial and hands. Verge escapement, steel balance. This movement is only one of about 10 known from this maker. For more information please see the book on Thomas Tompion by Jeremy Evans mentioned above. His name was probably derived from Pinchbeck, Lincolnshire. He was also maker of musical automata. He constructed musical automata that played tunes and imitated birds. He also sold self-playing organs, to save the expense of organists in country churches. At some point he was a partner with Isaac Fawkes a conjuror and showman. In he is said to have procured for George III the first pocket watch made with a compensation curb. One of the highlights of the book is the explanation of the secret of the learned pig. Christopher Pinchbeck I, London, No. Such mistakes are regularly made by some engravers. The outer case The inner part of the outer case features a later hand colored transfer print of the Madonna. Between the outer and inner case a stitched watchpaper with flowers and the date for He is credited with inventing several design improvements to the pendulum clock, inventing the mercury pendulum and also the orrery. However his greatest innovation was perfecting of the dead-beat escapement in , developed by Richard Towneley and Tompion in the mids. Between and , Graham had as an apprentice Thomas Mudge who went on to be an eminent watchmaker in his own right, and invented the lever escapement towards He was widely acquainted with practical astronomy, invented many valuable astronomical instruments, and improved others. Graham made for Edmond Halley the great mural quadrant at Greenwich Observatory, and also the fine transit instrument and the zenith sector used by James Bradley in his discoveries. He supplied the French Academy with the apparatus used for the measurement of a degree of the meridian, and constructed the most complete planetarium known at that time, in which the motions of the celestial bodies were demonstrated with great accuracy. He was also one of the first to notice that auroras are related to magnetic field variations. The compass needles he produced as an instrument-maker were used by many of contemporary magneticians. This is underlined by the fact, that he refused to patent his inventions, wanting to make them accessible for all watchmakers. George Graham, London, No. Pierced and engraved cock with diamond endstone, solid engraved foot and plate for the silver regulator disc. Fusee and chain with worm and wheel barrel. Plain three arm steel balance, blued steel spiral hairspring. Polished steel cylinder, large brass escape wheel. Winding through the original gold, white enameled dial. Roman and Arabic numerals, gold beetle and poker hands. The minute hand is cranked in order to miss the winding square. Contemporary gilt inner case. The inside of the cap is scratched with the movement number, a typical Graham workshop custom. One of the earliest 13 known watches with cylinder escapement. This type of escapement had been designed by Tompion, and patented by Edward Barlow, William Houghton, and Tompion in Surviving original white enamelled gold examples are rare 1. Also, he stopped using pierced cock foots and side plates only mounting plain engraved ones, as soon as he switched to cylinder escapements 1. Consequently he started also using gilt, brass caps, scratched with the movement number inside, not used for his former verge watches 1. All these changes were also applied by all his apprentices and employees, once they set up their own businesses. The cylinder escapement increased the precision of watches considerably. One of the only negatives is, that its components are rather delicate and sensitive to damage. For this reason the French watchmakers preferred the more robust verge escapement over the cylinder for many years, until Julien Le Roy started to use it regularly around Justin Vulliamy is thought to have visited Grahams workshop to learn about the cylinder escapement. Mudge, apprentice to Graham was an independent watchmaker from and took William Dutton, also apprentice of Graham, as partner from 1. Mudge was not the successor of Graham, even if it was him, who represented the quality and ingenuity of Graham on the long run. They apparently even had their placid and humble character in common. All former workmen and employees of George Graham, including Larcum Kendall, used the same movement setups and workshop customs for simple movements, once they set up businesses on their own. All watches having cylinder escapement made by these men have brass cylinder escapements and most retained the 13 teeth and the banking by pin in the cylinder 1. All used enamelled dials, many of them on gold, especially pieces by Mudge.

Chapter 4 : George Biddell Airy (Airy, George Biddell,) | The Online Books Page

Abstract Transits at Liverpool, Kingstown, Valentia. With one plate: Map shewing the Geodetic Connexion between the Royal Observatory of Greenwich and the Observatories of Liverpool, Kingstown and Feach Main.

Save Monuments of International Longitude Determination at Sheshan Observatory , Shanghai The history of longitude is a record of the effort, by astronomers, cartographers and navigators over several centuries, to discover a means of determining longitude. The measurement of longitude is important to both cartography and navigation , in particular to provide safe ocean navigation. Knowledge of both latitude and longitude was required. Finding an accurate and reliable method of determining longitude took centuries of study, and involved some of the greatest scientific minds in human history. Ancient history Eratosthenes in the 3rd century BC first proposed a system of latitude and longitude for a map of the world. By the 2nd century BC Hipparchus was the first to use such a system to uniquely specify places on Earth. He also proposed a system of determining longitude by comparing the local time of a place with an absolute time. This is the first recognition that longitude can be determined by accurate knowledge of time. In the 11th century Al-Biruni believed the earth rotated on its axis and this forms our modern notion of how time and longitude are related. For longitude, early ocean navigators had to rely on dead reckoning. This was inaccurate on long voyages out of sight of land and these voyages sometimes ended in tragedy as a result. Determining longitude at sea was also much harder than on land. A stable surface to work from, a comfortable location to live in while performing the work, and the ability to repeat determinations over time made various astronomical techniques possible on land such as the observation of eclipses that were unfortunately impractical at sea. Whatever could be discovered from solving the problem at sea would only improve the determination of longitude on land. They would sail to the latitude of their destination, turn toward their destination and follow a line of constant latitude. This was known as running down a westing if westbound, easting otherwise. This increased the likelihood of short rations,[3] which could lead to poor health or even death for members of the crew due to scurvy or starvation, with resultant risk to the ship. Errors in navigation have also resulted in shipwrecks. Motivated by a number of maritime disasters attributable to serious errors in reckoning position at sea, particularly such spectacular disasters as the Scilly naval disaster of , which took Admiral Sir Cloudesley Shovell and his fleet, the British government established the Board of Longitude in Prizes were offered in graduated amounts for solutions of increasing accuracy. Britain was not alone in the desire to solve the problem. It was charged with, among a range of other scientific activities, advancement of the science of navigation and the improvement of maps and sailing charts. Holland added to the effort with a prize offered in Due to the international effort in solving the problem and the scale of the enterprise, it represented one of the largest scientific endeavours in history. Time equals longitude Since at any instant in time, local solar time at a location varies by one hour for every 15 degrees change of longitude degrees divided by 24 hours , there is a direct relationship between time and longitude. Finding apparent local time is relatively easy. The problem, ultimately, was how to determine the time at a distant reference point while on a ship. Ptolomaei, published at Nuremberg in The method was discussed in detail by Petrus Apianus in his Cosmographicus liber Landshut I maintain that I learned [my longitude] In the roughly This is 13 degrees per day, or just over 0. So, while the rotation of the Earth causes the stars and the Moon to appear to move from east to west across the night sky, the Moon, because of its own orbit around the Earth, fights back against this apparent motion, and seems to move eastward or retrograde by about 0. In other words, the Moon "moves" west only He worked on this problem from time to time during the remainder of his life. To be successful, this method required the observation of the moons from the deck of a moving ship. To this end, Galileo proposed the celatone , a device in the form of a helmet with a telescope mounted so as to accommodate the motion of the observer on the ship. This would provide a platform that would allow the observer to remain stationary as the ship rolled beneath him, in the manner of a gimballed platform. However, it was used for longitude determination on land. Upon succeeding John Flamsteed in the post of Astronomer Royal , Halley had undertaken the task of observing both stellar positions and the path of the moon, with the intention of supplementing existing knowledge and advancing his proposal for determining longitude at sea. No reason was given by Halley for abandoning occultations. Appulses with brighter stars would be more practical. While he had tested the method at sea, it was never widely used or considered as a viable method. His observations did contribute to the lunar distance method. Halley also hoped that careful observations of magnetic deviations could provide a determination of longitude. The magnetic field of the Earth was not well understood at the time. Mariners had observed that magnetic north deviated from geographic north in many locations. Halley and others hoped that the pattern of deviation, if consistent, could be used to determine longitude. If the measured deviation matched that recorded on a chart, the position would be known. Halley used his voyages on the pink Paramour to study the magnetic variance and was able to provide maps showing the halleyan or isogonic lines. This method was eventually to fail as the localized variations from general magnetic trends make the method unreliable. They in turn consulted the astronomer John Flamsteed. At the same time, Sir Jonas Moore had suggested to King Charles the establishment of an observatory and proposed Flamsteed as the first Astronomer Royal. With the creation of the Royal Observatory, Greenwich and a program for measuring the positions of the stars with high precision, the process of gathering the data for a working method of lunar distances was under way. He had corresponded with Leonhard Euler , who contributed information and equations to describe the motions of the moon. The Admiralty passed them on to the Board of Longitude for evaluation and consideration for the Longitude Prize. James Bradley , the Astronomer Royal at that time, evaluated the tables, and found their predictions to be accurate to within half a degree. The calculations themselves, however, were extremely laborious and time-consuming. Being very enthusiastic for the lunar distance method, Maskelyne and his team of computers worked feverishly through the year , preparing tables for the new Nautical Almanac and Astronomical Ephemeris. Published first with data for the year , it included daily tables of the positions of the Sun, Moon, and planets and other astronomical data, as well as tables of lunar distances giving the distance of the Moon from the Sun and nine stars suitable for lunar observations ten stars for the first few years. Since it was based on the Royal Observatory, it helped lead to the international adoption a century later of the Greenwich Meridian as an international standard. Another proposed solution was to use a mechanical timepiece, to be carried on a ship, that would maintain the correct time at a reference location. The concept of using a clock can be attributed to Gemma Frisius. Attempts had been made on land using pendulum clocks, with some success. In particular, Huygens had made accurate pendulum clocks that made it possible to determine longitude on land. He also proposed the use of a balance spring to regulate clocks. There is some dispute as to whether he or Robert Hooke first proposed this idea. At that time, there were no clocks that could maintain accurate time while being subjected to the conditions of a moving ship. The rolling , pitching and yawing , coupled with the pounding of wind and waves, would knock existing clocks out of the correct time. In spite of this pessimism, a group felt that the answer lay in chronometry â€”developing an improved time piece that would work even on extended voyages at sea. A suitable timepiece was eventually built by John Harrison , a Yorkshire carpenter, with his marine chronometer; that timepiece was later known as H Harrison built five, two of which were tested at sea. His first, H-1, was not tested under the conditions that were required by the Board of Longitude. Instead, the Admiralty required that it travel to Lisbon and back. It lost considerable time on the outward voyage but performed excellently on the return leg, which was not part of the official trial. The perfectionist in Harrison prevented him from sending it on the required trial to the West Indies and in any case it was regarded as too large and impractical for service use. He instead embarked on the construction of H This chronometer never went to sea, and was immediately followed by H During construction of H-3, Harrison realised that the loss of time of the H-1 on the Lisbon outward voyage was due to the mechanism loosing time every time the ship came about while tacking down the English Channel. Harrison produced H-4, with a completely different mechanism which did get its sea trial and satisfied all the requirements for the Longitude Prize. However, he was not awarded the prize and was forced to fight for his reward. Though the British Parliament rewarded John Harrison for his marine chronometer in , his chronometers were not to become standard. Chronometers such as those by Thomas Earnshaw were suitable for general nautical use by the middle of the 19th century Early trials of the method could involve four hours of effort. Between and earlier in British and French navigation practice, later in American, Russian, and other maritime countries , affordable, reliable marine chronometers became available, with a trend to replace the method of lunars as soon as they could reach the market in large numbers. It became possible to buy three or more chronometers, serving for checking on each other redundancy , although according to Nathaniel Bowditch, their use was precluded because they were very expensive, [16] obviously much higher than a single sextant of sufficient quality for lunar distance navigation which continued in use until Three chronometers provided triple modular redundancy , allowing error correction if one of the three was wrong, so the pilot would take the average of the two with closer readings average precision vote. There is an old adage to this effect, stating: Nonetheless, expert navigators continued to learn lunars as late as , though for most this was a textbook exercise since they were a requirement for certain licenses. They also continued in use in land exploration and mapping where chronometers could not be kept secure in harsh conditions. The British Nautical Almanac published lunar distance tables until and the instructions until The development of wireless telegraph time signals in the early 20th century, used in combination with marine chronometers, put a final end to the use of lunar distance tables. Modern solutions Telegraph signals were used regularly for time coordination by the United States Naval Observatory starting in Another regular broadcast began in Halifax, Nova Scotia in , and time signals that became more widely used were broadcast from the Eiffel Tower starting in This method drastically reduced the importance of lunars as a means of verifying chronometers. Modern sailors have a number of choices for determining accurate positional information, including radar and the Global Positioning System, commonly known as GPS , a satellite navigation system. With technical refinements that make position fixes accurate to within meters, the radio-based LORAN system was used in the late 20th Century but has been discontinued in North America. Combining independent methods is used as a way to improve the accuracy of position fixes. Even with the availability of multiple modern methods of determining longitude, a marine chronometer and sextant are routinely carried as a backup system.

Chapter 5 : Browse subject: Prime Meridian | The Online Books Page

Determination of the longitude of Valentia in Ireland: by transmission of chronometers. by George Biddell Airy 1 edition - first published in On the algebraical and numerical theory of errors of observations: and the combinations of observations.

This website uses JavaScript and style sheets. Please ensure that they are enabled in your browser. The objectives of Liverpool Observatory were: To determine longitude at Liverpool. To obtain and preserve Greenwich time for the benefit of Liverpool by rating and testing chronometers. To make astronomical observations to make accurate meteorological observations to supply to the Registrar General who published quarterly returns of the mortality in England At that time, the longitude at Liverpool was uncertain, as was local time. Hartnup obtained time from the observation of the stars, ie, sidereal time, which was kept by a sidereal clock at the Observatory. There is one more sidereal day in a year than a solar day, so the sidereal clock gained one second every six minutes and six seconds. When the seconds of the sidereal clock and the solar clock coincided, calculations were made to maintain the accuracy of the solar clock. To convert Liverpool time to Greenwich time, the difference in longitude was calculated. To find the longitude at sea, it was necessary firstly to determine local time, and secondly to find Greenwich time at the same moment. The difference between the two is the longitude. Greenwich time at sea was often determined by the observation of lunar distances, which was often not possible. A much easier way was by chronometer. It was very important therefore that chronometers should be accurate so that the exact position of ships could be calculated. Hartnup set up a series of chambers at the Observatory, heated to various specific temperatures, and chronometers were brought by sea captains to the Observatory to be tested through these temperatures. Hartnup proved that chronometers inaccuracies were usually due to the changes in temperature that they were subjected to on their voyages. The citizens of Liverpool were then able to check their timepieces. Soon after the Observatory was built, the Astronomer Royal wanted to know the difference in longitude between Valentia, in Ireland, and Greenwich. This had previously been impossible due to the unreliability of chronometers on ships that crossed the Atlantic. Over the next few years, several hundred fully tested chronometers were loaded onto naval vessels and crossed and recrossed the Atlantic. Hartnup also devised a new balance for chronometers, 5 of which were made and fitted by a Liverpool manufacturer, Mr Shepherd, and employed on the expedition. These were tested through a range of degrees Fahrenheit, with favourable results. On the successful conclusion of this experiment, Professor Bond presented Liverpool Observatory with a fine sidereal clock. With so much experience of testing chronometers and the successful outcome of the Atlantic expedition, Hartnup was now in a position to advise and assist the Astronomer Royal to set up similar testing chambers to the ones at Liverpool Observatory, so that he also could test and rate chronometers. Hartnup set up a fully operational meteorological station, recording temperatures, rainfall, barometric pressure and cloud cover. In Alfred King of Liverpool invented the barograph, with guidance from Hartnup. Having resolved the longitude problem, provided accurate time to Liverpool and set up a successful chronometer testing system, Hartnup then recommended to the Observatory Committee of the Town Council that a more scientific character should be given to the Observatory. His observations were considered by astronomers to have increased the accuracy of navigation, extended the practical astronomy of Great Britain and added to the knowledge of the universe. In the large equatorial telescope was used when taking photographs of the moon. The photographs were projected to show the moon with a diameter of 50 feet, to much acclaim. Under the direction of the Board of Trade, the Observatory then began supplying ships with Azimuth compasses. These were supplied free, on condition that records of observations be returned to the Meteorological Department of the Board of Trade. The object of this research was to improve the safety of vessels and assist improvements in variation charts. Soon afterwards, barometers and thermometers were supplied to ships under a similar arrangement. As the Observatory became more renowned for its pioneering work, New York showed interest in also setting up a

Nautical Observatory similar to that at Liverpool and Hartnup was able to render his assistance. In order to provide accurate time to more people, in the clock at Exchange Building was electrically connected to the Observatory. The following year the Town Hall clock was also linked. In , with the re-development of Waterloo Dock, the observatory was relocated to Bidston Hill. This was a larger building, with better facilities. Chronometers continued to be tested and rated for shipping. Meteorological and astronomical observations continued to be made. In order to continue to provide time to Liverpool, a time gun was used, which was placed on the dockside at Birkenhead and electrically controlled, from the Observatory. In John Hartnup retired, being succeeded by his son.

Chapter 6 : History of longitude | Revolvy

Determination of the longitude of Valentia in Ireland by transmission of chronometers. ([London,]), by George Biddell Airy (page images at HathiTrust) Tables for correcting the apparent distance of the moon and a star from the effects of refraction and parallax.

Showing an apparent difference of time of 4m 0s. This is technically called the "wave and armature time. Some English astronomers have objected that, where the line is, as is usual in long land-lines, divided into lengths connected by telegraphic repeaters, the time of transmission will not be the same in both directions, and that the same effect would be produced in a submarine cable having an imperfection or leak nearer one end than the other. Experiments, however, by the Coast Survey on the long line from Washington to San Francisco indicate that this objection, though theoretically true, is of no practical importance. Upon land-lines the time-signals sent can be recorded directly on the chronograph by putting it in the telegraphic circuit; but, with submarine cables, the electric impulse transmitted is not strong enough to act upon the electro-magnets of the chronograph-pen. For telegraphing with weak impulses over submarine lines a very beautiful device was invented by Sir William Thomson, and is now in general use. To a delicately suspended magnet, surrrounded by a coil of fine covered wire, a small mirror is attached. From this mirror a beam of light from a lamp is reflected on a scale in a dark room. When no currents are being sent over the line, this beam remains at rest; but, when, at the sending station, either of two keys is pressed, a positive or negative current, as the case may be, is sent through the cable, and through the coil surrounding the magnet, causing the magnet with its mirror to turn and to deflect the ray of light to the right or left. When the signal arrives and is perceived, the observer touches his chronograph-key, thus recording the time of its arrival. The authority of the Navy Department was readily obtained, and the necessary preparations were commenced in the spring of In order that the work might be accomplished with economy, as small a vessel as possible was desirable, the Fortune, a strong iron tugboat of tons, being selected and prepared. Although this little vessel carried the officers and men of the expedition safely, she was found to be too small to encounter heavy weather at sea with any degree of comfort. The astronomical outfit was superintended by Mr. Rogers, of the Hydrographic Office, and was in all respects satisfactory. The telescopes used were constructed at the repair-shop of the Hydrographic Office for the purpose, and were a combination of the transit instrument with the zenith telescope, a modification working admirably in practice, and first suggested by Prof. Lyman, of Yale College. These instruments were so constructed that the eyepiece was at one end of the horizontal axis, a prism at the junction of the axis and telescope-tube reflecting at a right angle the rays from the object-glass, thereby enabling the observer to direct the instrument upon stars of any elevation above the horizon without change of position. The command of the expedition was given to Lieutenant-Commander F. Upon the dispersion of the assembled squadron in April, , Lieutenant-Commander Green was directed to complete a survey of the Mexican Gulf coast, commenced by the United States steamship Wyoming. This work employed the time till the following August, when the Fortune returned to Washington, and was at once refitted for the prosecution of the original design. Fortunately for the success of the work, the services of Mr. Miles Rock, formerly of the observatory at Cordova, were secured as principal astronomical assistant; and the Fortune sailed on the 24th of November, , from Hampton Roads for Jamaica. Upon arrival at Kingston, definite arrangements were made with the manager of the telegraph cables, the gratuitous use of which had been offered very promptly and courteously by the London board of directors. As it had been decided to commence the work by measuring between Panama and Aspinwall, the Fortune sailed for the latter place on the 9th of December, arriving on the 12th. Portable observatories had been constructed, to shelter the instruments and observers, and were immediately set up at Panama and Aspinwall upon obtaining permission from the local authorities. Throughout the work the same general system was pursued, and was briefly as follows: As soon as practicable after the establishment of a party at each station, the work was commenced by observing stars on five clear nights, from

8 to 10 p. This was effected as follows: Telegraphic communication being established between the observatories, the senior observer sent a preparatory signal at ten seconds before the completion of a minute by tapping his key several times in quick succession; then exactly at the even minute, pressing his key again for about a quarter of a second, and repeating this signal at intervals of five seconds till the completion of the next even minute. The hour and minute when the first signal was sent were then telegraphed to the receiving station and repeated to insure correctness. The time of arrival of these signals was recorded by the chronograph at the receiving stations, and five similar sets were exchanged in each direction, making sixty-five comparisons each way. After five nights of this work, zenith telescope observations of pairs of stars were made on four nights for latitude. In this way, during the winter, the stations of Panama, Aspinwall, Kingston, Santiago de Cuba, and Havana, were occupied, the exact difference of time between each station and the next and the latitude of each being ascertained. It was intended to continue the work to Key West, thus connecting with a Coast Survey station, but the occurrence of yellow fever among the crew of the Fortune, and the breaking out of that disease at Key West, caused the postponement of this measurement till the next season. By combining these ascertained differences of time, and applying the result to a determined position, the longitude of each place will be decided with a very small limit of error. In addition to the above observations, the exact habitual error of observing, or relative personal equation of the two observers, must be ascertained and applied to the result. The authorities of each country visited extended the most gratifying courtesy and assistance to the officers of the expedition. Especially was this the case in the island of Cuba, where a Spanish naval officer was detailed to assist in the work. On the 5th of April last, all work practicable during this season being finished, the Fortune left Havana, completing her cruise by arriving at the Washington Navy-Yard on the 12th of the same month. The computation of the numerous observations made during the past winter is now being prepared, and, as soon as completed, the results will be published. Some improvements and modifications, which the experience of the past year has suggested, will be made in the instruments and outfit, and the same officers in a larger and more commodious vessel will leave the United States during the coming autumn, to continue the measurements through the Virgin and Windward Islands to the coast of South America. In connection with their preparations for observing the recent transit of Venus, German astronomers have made some telegraphic measurements of differences of time in the East Indies; but the vast and constantly increasing net-work of cables nearly surrounding the earth will afford work for years to come, and will, in a way hardly contemplated by the projectors, add in a very great degree to accurate geographical knowledge.

Chapter 7 : Tuvalu - Wikipedia

This is because longitude determination had progressed from Harvard to Calais in When the ship Great Eastern landed the transatlantic telegraph cable (from Valentia Island, Ireland) at Heart's Content, Newfoundland, the Coast Survey began completing the work eastward from Greenwich to Calais.

The sun rising over Stonehenge on the June solstice Many ancient civilizations observed astronomical bodies , often the Sun and Moon , to determine times, dates, and seasons. History of timekeeping devices in Egypt Sundials have their origin in shadow clocks , which were the first devices used for measuring the parts of a day. One type of shadow clock consisted of a long stem with five variable marks and an elevated crossbar which cast a shadow over those marks. It was positioned eastward in the morning, and was turned west at noon. Obelisks functioned in much the same manner: The obelisk also indicated whether it was morning or afternoon, as well as the summer and winter solstices. It measured the passage of time by the shadow cast by its crossbar on a non-linear rule. The T was oriented eastward in the mornings, and turned around at noon , so that it could cast its shadow in the opposite direction. One type consisted of a bowl with small holes in its bottom, which was floated on water and allowed to fill at a near-constant rate; markings on the side of the bowl indicated elapsed time, as the surface of the water reached them. When the hourglass was turned over, grains of sand fell at a constant rate from one chamber to the other. The time was accurately measured by observing certain stars as they crossed the line created with the merkhets. Clepsydra, literally water thief, was the Greek word for water clock. The vat held a steadily increasing amount of water, supplied by a cistern. By morning, the vessel would have floated high enough to tip over, causing the lead balls to cascade onto a copper platter. Water emptied until it reached the siphon, which transported the water to the other jar. There, the rising water would force air through a whistle, sounding an alarm. Greek astronomer, Andronicus of Cyrrhus , supervised the construction of the Tower of the Winds in Athens in the 1st century B. There are several mentions of this in historical records and literature of the era; for example, in Theaetetus , Plato says that "Those men, on the other hand, always speak in haste, for the flowing water urges them on". Up stepped an old man, whom I did not know. He was invited to speak for as long as there was water in the clock; this was a hollow globe into which water was poured through a funnel in the neck, and from which it gradually escaped through fine perforations at the base". Another consisted of a bowl with a hole in its centre, which was floated on water. Time was kept by observing how long the bowl took to fill with water. One of the more common problems in most types of clepsydrae was caused by water pressure: Along with this improvement, clocks were constructed more elegantly in this period, with hours marked by gongs, doors opening to miniature figurines, bells, or moving mechanisms. Water flows more slowly when cold, or may even freeze. The mathematician and astronomer Theodosius of Bithynia , for example, is said to have invented a universal sundial that was accurate anywhere on Earth, though little is known about it. Marcus Vitruvius Pollio , the Roman author of De Architectura , wrote on the mathematics of gnomons , or sundial blades. Its gnomon was an obelisk from Heliopolis. Joseph Needham speculated that the introduction of the outflow clepsydra to China, perhaps from Mesopotamia , occurred as far back as the 2nd millennium BC, during the Shang Dynasty , and at the latest by the 1st millennium BC. To compensate for the falling pressure head in the reservoir, which slowed timekeeping as the vessel filled, Zhang Heng added an extra tank between the reservoir and the inflow vessel. Around AD, Yin Gui was the first in China to write of the overflow or constant-level tank added to the series, which was later described in detail by the inventor Shen Kuo. Around , this design was trumped by two Sui Dynasty inventors, Geng Xun and Yuwen Kai, who were the first to create the balance clepsydra, with standard positions for the steelyard balance. With this arrangement no overflow tank was required, and the two attendants were warned when the clepsydra needed refilling. The added complexity was aimed at regulating the flow and at providing fancier displays of the passage of time. For example, some water clocks rang bells and gongs , while others opened doors and windows to show figurines of people, or moved pointers, and dials. Some even displayed astrological models of the universe. Some of the most elaborate water clocks were designed by Muslim engineers. In particular, the water clocks by Al-Jazari in are credited for going "well beyond anything" that had preceded them. In his treatise, he describes one of his water clocks, the elephant clock. The clock recorded the passage of temporal hours, which meant that the rate of flow had to be changed daily to match the uneven length of days throughout the year. To accomplish this, the clock had two tanks: At daybreak the tap was opened and water flowed from the top tank to the bottom tank via a float regulator that maintained a constant pressure in the receiving tank. According to the poem, the graduated candle was a means of determining time at night. Similar candles were used in Japan until the early 10th century. Once lit, the candles were placed in wooden framed glass boxes, to prevent the flame from extinguishing. One of his candle clocks included a dial to display the time and, for the first time, employed a bayonet fitting , a fastening mechanism still used in modern times. The candle, whose rate of burning was known, bore against the underside of the cap, and its wick passed through the hole. Wax collected in the indentation and could be removed periodically so that it did not interfere with steady burning. The bottom of the candle rested in a shallow dish that had a ring on its side connected through pulleys to a counterweight. As the candle burned away, the weight pushed it upward at a constant speed. The automata were operated from the dish at the bottom of the candle. No other candle clocks of this sophistication are known. These early timekeeping devices consisted of a graduated glass reservoir to hold oil â€" usually whale oil, which burned cleanly and evenly â€" supplying the fuel for a built-in lamp. As the level in the reservoir dropped, it provided a rough measure of the passage of time. Incense clocks Main article: Incense clock In addition to water, mechanical, and candle clocks, incense clocks were used in the Far East , and were fashioned in several different forms. Schafer speculated that incense clocks were invented in India. The weights would drop onto a platter or gong below, signifying that a certain amount of time had elapsed. Some incense clocks were held in elegant trays; open-bottomed trays were also used, to allow the weights to be used together with the decorative tray. Different powdered incense clocks used different formulations of incense, depending on how the clock was laid out. This allowed craftsmen to more easily create both large and small seals, as well as design and decorate them more aesthetically. Another advantage was the ability to vary the paths of the grooves, to allow for the changing length of the days in the year. As smaller seals became more readily available, the clocks grew in popularity among the Chinese, and were often given as gifts. The mechanism was also used in Greek water clocks. The earliest instance of a liquid-driven escapement was described by the Greek engineer Philo of Byzantium fl. Water, flowing into scoops, turned a wheel automatically, rotating it one complete revolution in one day and night. Besides this, there were two rings fitted around the celestial sphere outside, having the sun and moon threaded on them, and these were made to move in circling orbit And they made a wooden casing the surface of which represented the horizon, since the instrument was half sunk in it. It permitted the exact determinations of the time of dawns and dusks, full and new moons, tarrying and hurrying. Moreover, there were two wooden jacks standing on the horizon surface, having one a bell and the other a drum in front of it, the bell being struck automatically to indicate the hours, and the drum being beaten automatically to indicate the quarters. All these motions were brought about by machinery within the casing, each depending on wheels and shafts, hooks, pins and interlocking rods, stopping devices and locks checking mutually. Another noteworthy clock, the elaborate Cosmic Engine, was built by Su Song , in It also featured five panels with mannequins ringing gongs or bells, and tablets showing the time of day, or other special times. It was constructed by the Arab engineer al-Kaysarani in Heavy floats were used as weights and a constant-head system was used as an escapement mechanism, [4] which was present in in the hydraulic controls they used to make heavy floats descend at a slow and steady rate. However, the device was actually a compartmented cylindrical water clock, [72] which the Jewish author of the relevant section, Rabbi Isaac, constructed using principles described by a philosopher named "Iran", identified with Heron of Alexandria fl. During the 11th century in the Song Dynasty , the Chinese astronomer , horologist and mechanical engineer Su Song created a water-driven astronomical clock for his clock tower of Kaifeng City. It incorporated an escapement mechanism as well as the earliest known endless power-transmitting chain drive , which drove the armillary sphere. Contemporary Muslim astronomers also constructed a variety of highly accurate astronomical clocks for use in their mosques and observatories , [74] such as the water-powered astronomical clock by Al-Jazari in , [75] [76] and the astrolabic clock by Ibn al-Shatir in the early 14th century. These devices functioned as timekeeping devices and also as calenders. It included a display of the zodiac and the solar and lunar orbits , and a pointer in the shape of the crescent moon which travelled across the top of a gateway , moved by a hidden cart and causing automatic doors to open, each revealing a mannequin , every hour. As the ancient dials were nodus-based with straight hour-lines, they indicated unequal hoursâ€"also called temporary hoursâ€"that varied with the seasons. His sundial is the oldest polar-axis sundial still in existence. The concept appeared in Western sundials starting in However, the earliest evidence of their use appears in the painting Allegory of Good Government, by Ambrogio Lorenzetti , from The hourglass also took on symbolic meanings, such as that of death, temperance, opportunity, and Father Time , usually represented as a bearded, old man. The English word clock is said to derive from the Middle English clokke, Old North French cloque, or Middle Dutch clocke, all of which mean bell , and are derived from the Medieval Latin clocca, also meaning bell. Throughout history, clocks have had a variety of power sources , including gravity , springs , and electricity. Clocks were used in medieval monasteries to keep the regulated schedule of prayers. The clock continued to be improved, with the first pendulum clock being designed and built in the 17th century by Christiaan Huygens , a Dutch scientist. Early Western mechanical clocks The earliest medieval European clockmakers were Christian monks. This was done by various types of time-telling and recording devices, such as water clocks, sundials and marked candles, probably used in combination. The religious necessities and technical skill of the medieval monks were crucial factors in the development of clocks, as the historian Thomas Woods writes: The monks also counted skillful clock-makers among them. The first recorded clock was built by the future Pope Sylvester II for the German town of Magdeburg , around the year Much more sophisticated clocks were built by later monks. The framework is held together with metal dowels and pegs, and the escapement is the verge and foliot type, standard for clocks of this age. The power is supplied by two large stones, hanging from pulleys. As the weights fall, ropes unwind from the wooden barrels.

DOWNLOAD PDF DETERMINATION OF THE LONGITUDE OF VALENTIA IN IRELAND BY TRANSMISSION OF CHRONOMETERS

Chapter 8 : Bidston - The Hill

In addition to their regular work, both Hind and Dunkin were made use of by Airy in in his determination of the longitude of Valentia in Ireland by the transmission of chronometers. Like the rest of the magnetic staff, he was also required to occasionally observe with the Meridian Instruments.

Pre-history[edit] The origins of the people of Tuvalu are addressed in the theories regarding migration into the Pacific that began about years ago. During pre-European-contact times there was frequent canoe voyaging between the nearer islands including Samoa and Tonga. Possible evidence of fire in the Caves of Nanumanga may indicate human occupation for thousands of years. An important creation myth of the islands of Tuvalu is the story of the te Pusi mo te Ali the Eel and the Flounder who created the islands of Tuvalu ; [6] te Ali the flounder is believed to be the origin of the flat atolls of Tuvalu and the te Pusin the Eel is the model for the coconut palms that are important in the lives of Tuvaluans. The stories as to the ancestors of the Tuvaluans vary from island to island. On Niutao , [7] Funafuti and Vaitupu , the founding ancestor is described as being from Samoa , [8] [9] whereas on Nanumea , the founding ancestor is described as being from Tonga. Captain George Barrett of the Nantucket whaler Independence II has been identified as the first whaler to hunt the waters around Tuvalu. Murray, [23] the earliest European missionary in Tuvalu, reported that in about people were taken from Funafuti and about were taken from Nukulaelae, [15] as there were fewer than of the recorded in as living on Nukulaelae. Murray of the LMS â€" a Protestant congregationalist missionary society â€" arrived as the first European missionary, where he too proselytised among the inhabitants of Tuvalu. Protestantism was well established by , with preachers on each island. He married Salai, the daughter of the paramount chief of Funafuti. Some islands would have competing traders, while dryer islands might only have a single trader. Drilling occurred in , and Second World War[edit] During the Pacific War , Funafuti was used as a base to prepare for the subsequent seaborne attacks on the Gilbert Islands Kiribati that were occupied by Japanese forces. The Japanese had already occupied Tarawa and other islands in what is now Kiribati , but were delayed by the losses at the Battle of the Coral Sea. The islanders assisted the American forces to build airfields on Funafuti , Nanumea and Nukufetau and to unload supplies from ships. In that year a general election was held, [74] and a referendum was held in December to determine whether the Gilbert Islands and Ellice Islands should each have their own administration. The Tuvaluan Order , which took effect on 1 October , recognised Tuvalu as a separate British dependency with its own government. The second stage occurred on 1 January , when separate administrations were created out of the civil service of the Gilbert and Ellice Islands Colony. The House of Assembly was dissolved in July , with the government of Toaripi Lauti continuing as a caretaker government until the elections were held. On 5 September , Tuvalu became the th member of the United Nations.

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Chapter 9 : Insight into marine science | Observatory history | Directors

This paper explores how nineteenth-century Liverpool became such an advanced city with regard to public timekeeping, and the wider impact of this on the standardisation of time. From the mids, local scientists and municipal bodies in the port city were engaged in improving the ways in which.

From a maritime perspective, navigation is a much more structured and collaborative process which involves planning, recording and controlling the movement of vessels from one place to another. Maritime Navigation Begins The very earliest sailors navigated close to shore using their knowledge of coastal landmarks and natural phenomena birds, clouds, tides, floating debris to guide them. The celestial bodies â€" the sun by day and the stars by night â€" also helped guide mariners, and still do today. The first AtoN was developed, it is estimated, in BC when a lighthouse was built to mark the entry to the port of Alexandria in Egypt. This impressive lighthouse was even one of the seven wonders of the ancient world. We were already navigating our way with magnetic compasses and types of quadrants. The first navigational charts had also appeared. The speed of a vessel was calculated by throwing a log overboard on a rope with knots tied at known intervals and measuring how many knots played out over a set time interval. Detailed navigational charts covering the known world also became available to guide mariners. The use of lighthouses was becoming more common, and the first floating AtoN to include a burning light was the Lightship Nore, established at the mouth of the River Thames in London in This explains the vital importance of these AtoNs in facilitating safe sea travel as it was so critical that national AtoN providers were established. In the s, radio technology was in its infancy, and the nature of AtoNs had not changed dramatically for many years. Though there are no longer lighthouse keepers at these stations, these aids are still provided, and are now sometimes known as traditional AtoNs. Technological Advances Over the course of the last century and to the present day, huge advances have been made in terms of terrestrial and extraterrestrial communication â€" particularly in the fields of radio and satellite navigation respectively. The more notable terrestrial-based systems have been radio beacons, Radio Detection and Ranging Radar , Decca , and Loran. Today, ships have a wealth of systems with which to determine their position, course, and speed relative to hazards and other vessels. Though new technologies have emerged, navigating by eye using visual AtoNs still plays a huge role in marine safety. Not all those who use our seas are equipped with satellite navigation systems and the latest technology. And, of course, one of the key principles in AtoN provision is that there must be alternatives available in the case of failure of any system. A mix of systems is critical to ensuring safe navigation. More in this Category.