= Edward Wright (mathematician) =

Edward Wright (baptised 8 October 1561 ; died November 1615) was an English mathematician and cartographer noted for his book Certaine Errors in Navigation (1599 ; 2nd ed . , 1610) , which for the first time explained the mathematical basis of the Mercator projection , and set out a reference table giving the linear scale multiplication factor as a function of latitude , calculated for each minute of arc up to a latitude of 75 ° . This was in fact a table of values of the integral of the secant function , and was the essential step needed to make practical both the making and the navigational use of Mercator charts .

Wright was born at Garveston and educated at Gonville and Caius College , Cambridge , where he became a fellow from 1587 to 1596 . In 1589 the College granted him leave after Elizabeth I requested that he carry out navigational studies with a raiding expedition organised by the Earl of Cumberland to the Azores to capture Spanish galleons . The expedition 's route was the subject of the first map to be prepared according to Wright 's projection , which was published in Certaine Errors in 1599 . The same year , Wright created and published the first world map produced in England and the first to use the Mercator projection since Gerardus Mercator 's original 1569 map .

Not long after 1600 Wright was appointed as surveyor to the New River project , which successfully directed the course of a new man @-@ made channel to bring clean water from Ware , Hertfordshire , to Islington , London . Around this time , Wright also lectured mathematics to merchant seamen , and from 1608 or 1609 was mathematics tutor to the son of James I , the heir apparent Henry Frederick , Prince of Wales , until the latter 's very early death at the age of 18 in 1612 . A skilled designer of mathematical instruments , Wright made models of an astrolabe and a pantograph , and a type of armillary sphere for Prince Henry . In the 1610 edition of Certaine Errors he described inventions such as the " sea @-@ ring " that enabled mariners to determine the magnetic variation of the compass , the sun 's altitude and the time of day in any place if the latitude was known ; and a device for finding latitude when one was not on the meridian using the height of the pole star .

Apart from a number of other books and pamphlets , Wright translated John Napier 's pioneering 1614 work which introduced the idea of logarithms from Latin into English . This was published after Wright 's death as A Description of the Admirable Table of Logarithmes (1616) . Wright 's work influenced , among other persons , Dutch astronomer and mathematician Willebrord Snellius ; Adriaan Metius , the geometer and astronomer from Holland ; and the English mathematician Richard Norwood , who calculated the length of a degree on a great circle of the earth using a method proposed by Wright .

= = Family and education = =

The younger son of Henry and Margaret Wright , Edward Wright was born in the village of Garveston in Norfolk , East Anglia , and was baptised there on 8 October 1561 . It is possible that he followed in the footsteps of his elder brother Thomas (died 1579) and went to school in Hardingham . The family was of modest means , and he matriculated at Gonville and Caius College , University of Cambridge , on 8 December 1576 as a sizar . Sizars were students of limited means who were charged lower fees and obtained free food and / or lodging and other assistance during their period of study , often in exchange for performing work at their colleges .

Wright was conferred a Bachelor of Arts (B.A.) in 1580 ? 1581 . He remained a scholar at Caius , receiving his Master of Arts (M.A.) there in 1584 , and holding a fellowship between 1587 and 1596 . At Cambridge , he was a close friend of Robert Devereux , later the Second Earl of Essex , and met him to discuss his studies even in the weeks before Devereux 's rebellion against Elizabeth I in 1600 ? 1601 . In addition , he came to know the mathematician Henry Briggs ; and the soldier and astrologer Christopher Heydon , who was also Devereux 's friend . Heydon later made astronomical observations with instruments Wright made for him .

= = Foreign expedition = =

In 1589 , two years after being appointed to his fellowship , Wright was requested by Elizabeth I to carry out navigational studies with a raiding expedition organised by the Earl of Cumberland to the Azores to capture Spanish galleons . The Queen effectively ordered Caius to grant him leave of absence for this purpose , although the College expressed this more diplomatically by granting him a sabbatical " by Royal mandate " . Wright participated in the confiscation of " lawful " prizes from the French , Portuguese and Spanish ? Derek Ingram , a life fellow of Caius , has called him " the only Fellow of Caius ever to be granted sabbatical leave in order to engage in piracy " . Wright sailed with Cumberland in the Victory from Plymouth on 8 June 1589 ; they returned to Falmouth on 27 December of the same year . An account of the expedition is appended to Wright 's work Certaine Errors of Navigation (1599) , and while it refers to Wright in the third person it is believed to have been written by him .

In Wright 's account of the Azores expedition , he listed as one of the expedition 's members a " Captaine Edwarde Carelesse , alias Wright , who in S. Frauncis Drakes West @-@ Indian voiage was Captaine of the Hope " . In another work , The Haven @-@ finding Art (1599) (see below) , Wright stated that " the time of my first employment at sea " was " now more than tenne yeares since " . The Oxford Dictionary of National Biography asserts that during the expedition Wright called himself " Captain Edward Carelesse " , and that he was also the captain of the Hope in Sir Francis Drake 's voyage of 1585 ? 1586 to the West Indies , which evacuated Sir Walter Raleigh 's Colony of Virginia . One of the colonists was the mathematician Thomas Harriot , and if the Dictionary is correct it is probable that on the return journey to England Wright and Harriot became acquainted and discussed navigational mathematics . However , in a 1939 article , E.J.S. Parsons and W.F. Morris note that in Capt. Walter Bigges and Lt. Crofts ' book A Summarie and True Discourse of Sir Frances Drakes West Indian Voyage (1589) , Edward Careless was referred to as the commander of the Hope , but Wright was not mentioned . Further , while Wright spoke several times of his participation in the Azores expedition , he never alluded to any other voyage . Although the reference to his " first employment " in The Haven @-@ finding Art suggests an earlier venture , there is no evidence that he went to the West Indies . Gonville and Caius College holds no records showing that Wright was granted leave before 1589 . There is nothing to suggest that Wright ever went to sea again after his expedition with the Earl of Cumberland .

Wright resumed his Cambridge fellowship upon returning from the Azores in 1589 , but it appears that he soon moved to London for he was there with Christopher Heydon making observations of the sun between 1594 and 1597 , and on 8 August 1595 Wright married Ursula Warren (died 1625) at the parish church of St. Michael , Cornhill , in the City of London . They had a son , Samuel (1596 ? 1616) , who was himself admitted as a sizar at Caius on 7 July 1612 . The St. Michael parish register also contains references to other children of Wright , all of whom died before 1617 . Wright resigned his fellowship in 1596 .

= = Mathematician and cartographer = =

= = = Certaine Errors in Navigation = = =

Wright helped the mathematician and globe maker Emery Molyneux to plot coastlines on his terrestrial globe , and translated some of the explanatory legends into Latin . Molyneux 's terrestrial and celestial globes , the first to be manufactured in England , were published in late 1592 or early 1593 , and Wright explained their use in his 1599 work Certaine Errors in Navigation . He dedicated the book to Cumberland , to whom he had presented a manuscript of the work in 1592 , stating in the preface it was through Cumberland that he " was first moved , and received maintenance to divert my mathematical studies , from a theorical speculation in the Universitie , to the practical demonstration of the use of Navigation " .

The most significant aspect of the book was Wright 's method for dividing the meridian ; an explanation of how he had constructed a table for the division ; and the uses of this information for

navigation . Essentially , the problem that occupied Wright was how to depict accurately a globe on a two @-@ dimensional map according to the projection used by Gerardus Mercator in his map of 1569 . Mercator 's projection was advantageous for nautical purposes as it represented lines of constant true bearing or true course , known as loxodromes or rhumb lines , as straight lines . However , Mercator had not explained his method .

On a globe , circles of latitude (also known as parallels) get smaller as they move away from the Equator towards the North or South Pole . Thus , in the Mercator projection , when a globe is " unwrapped " on to a rectangular map , the parallels need to be stretched to the length of the Equator . In addition , parallels are further apart as they approach the poles . Wright compiled a table with three columns . The first two columns contained the degrees and minutes of latitudes for parallels spaced 10 minutes apart on a sphere , while the third column had the parallel 's projected distance from the Equator . Any cartographer or navigator could therefore lay out a Mercator grid for himself by consulting the table . Wright explained :

I first thought of correcting so many gross errors ... in the sea chart , by increasing the distances of the parallels , from the equinoctial towards the poles , in such sort , that at every point of latitude in the chart , a part of the meridian might have the same proportion to the like part of the parallel , that it has in the globe .

While the first edition of Certaine Errors contained an abridged table six pages in length , in the second edition which appeared in 1610 Wright published a full table across 23 pages with figures for parallels at one @-@ minute intervals . The table is remarkably accurate ? American geography professor Mark Monmonier wrote a computer program to replicate Wright 's calculations , and determined that for a Mercator map of the world 3 feet (0 @.@ 91 m) wide , the greatest discrepancy between Wright 's table and the program was only 0 @.@ 00039 inches (0 @.@ 0099 mm) on the map . In the second edition Wright also incorporated various improvements , including proposals for determining the magnitude of the Earth and reckoning common linear measurements as a proportion of a degree on the Earth 's surface " that they might not depend on the uncertain length of a barley @-@ corn " ; a correction of errors arising from the eccentricity of the eye when making observations using the cross @-@ staff ; amendments in tables of declinations and the positions of the sun and the stars , which were based on observations he had made together with Christopher Heydon using a 6 @-@ foot (1 @.@ 8 m) quadrant ; and a large table of the variation of the compass as observed in different parts of the world , to show that it is not caused by any magnetic pole . He also incorporated a translation of Rodrigo Zamorano 's Compendio de la Arte de Navegar (Compendium of the Art of Navigation , Seville , 1581 ; 2nd ed . , 1588) .

Wright was prompted to publish the book after two incidents of his text , which had been prepared some years earlier , being used without attribution . He had allowed his table of meridional parts to be published by Thomas Blundeville in his Exercises (1594) and in William Barlow 's The Navigator 's Supply (1597) , although only Blundeville acknowledged Wright by name . However , an experienced navigator , believed to be Abraham Kendall , borrowed a draft of Wright 's manuscript and , unknown to him , made a copy of it which he took on Sir Francis Drake 's 1595 expedition to the West Indies . In 1596 Kendall died at sea . The copy of Wright 's work in his possession was brought back to London and wrongly believed to be by Kendall , until the Earl of Cumberland passed it to Wright and he recognised it as his work . Also around this time , the Dutch cartographer Jodocus Hondius borrowed Wright 's draft manuscript for a short time after promising not to publish its contents without his permission . However , Hondius then employed Wright 's calculations without acknowledging him for several regional maps and in his world map published in Amsterdam in 1597 . This map is often referred to as the " Christian Knight Map " for its engraving of a Christian knight battling sin , the flesh and the Devil . Although Hondius sent Wright a letter containing a faint apology , Wright condemned Hondius 's deceit and greed in the preface to Certaine Errors . He wryly commented : " But the way how this [Mercator projection] should be done , I learned neither of Mercator , nor of any man els . And in that point I wish I had beene as wise as he in keeping it more charily to myself " .

The first map to be prepared according to Wright 's projection was published in his book , and showed the route of Cumberland 's expedition to the Azores . A manuscript version of this map is

preserved at Hatfield House ; it is believed to have been drawn about 1595 . Following this , Wright created a new world map , the first map of the globe to be produced in England and the first to use the Mercator projection since Gerardus Mercator 's 1569 original . Based on Molyneux 's terrestrial globe , it corrected a number of errors in the earlier work by Mercator . The map , often called the Wright ? Molyneux Map , first appeared in the second volume of Richard Hakluyt 's The Principal Navigations , Voiages , Traffiques and Discoueries of the English Nation (1599) . Unlike many contemporary maps and charts which contained fantastic speculations about unexplored lands , Wright 's map has a minimum of detail and blank areas wherever information was lacking . The map was one of the earliest to use the name " Virginia " . Shakespeare alluded to the map in Twelfth Night (1600 ? 1601) , when Maria says of Malvolio : " He does smile his face into more lynes , than is in the new Mappe , with the augmentation of the Indies . " Another world map , larger and with updated details , appeared in the second edition of Certaine Errors (1610) .

Wright translated into English De Havenvinding (1599) by the Flemish mathematician and engineer Simon Stevin , which appeared in the same year as The Haven @-@ Finding Art , or the Way to Find any Haven or Place at Sea , by the Latitude and Variation . He also wrote the preface to physician and scientist William Gilbert 's great work De Magnete , Magneticisque Corporibus , et de Magno Magnete Tellure (The Magnet , Magnetic Bodies , and the Great Magnet the Earth , 1600) , in which Gilbert described his experiments which led to the conclusion that the Earth was magnetic , and introduced the term electricus to describe the phenomenon of static electricity produced by rubbing amber (called ?lectrum in Classical Latin , derived from ' ???????? (elektron) in Ancient Greek) . According to the mathematician and physician Mark Ridley , chapter 12 of book 4 of De Magnete , which explained how astronomical observations could be used to determine the magnetic variation , was actually Wright 's work .

Gilbert had invented a dip @-@ compass and compiled a table recording the dip of the needle below the horizon . Wright believed that this device would prove to be extremely useful in determining latitude and , with the help of Blundeville and Briggs , wrote a small pamphlet called The Making , Description and Use of the Two Instruments for Seamen to find out the Latitude ... First Invented by Dr. Gilbert . It was published in 1602 in Blundeville 's book The Theoriques of the Seuen Planets . That same year he authored The Description and Use of the Sphære (not published till 1613) , and in 1605 published a new edition of the widely used work The Safegarde of Saylers .

= = = Surveying = = =

Wright also developed a reputation as a surveyor on land . He prepared " a plat of part of the waye whereby a newe River may be brought from Uxbridge to St. James , Whitehall , Westminster [,] the Strand , St Giles , Holbourne and London " , However , according to a 1615 paper in Latin in the annals of Gonville and Caius College , he was prevented from bringing this plan to fruition " by the tricks of others " . Nonetheless , early in the first decade of the 17th century , he was appointed by Sir Hugh Myddelton as surveyor to the New River project , which successfully directed the course of a new man @-@ made channel to bring clean water from Chadwell Spring at Ware , Hertfordshire , to Islington , London . Although the distance in a straight line from Ware to London is only slightly more than 20 miles (32 km) , the project required a high degree of surveying skill on Wright 's part as it was necessary for the river to take a route of over 40 miles following the 100 @-@ foot (30 m) contour line on the west side of the Lea Valley . As the technology of the time did not extend to large pumps or pipes , the water flow had to depend on gravity through canals or aqueducts over an average fall of 5 @.@ 5 inches a mile (approximately 8 @.@ 7 centimetres per kilometre) .

Work on the New River started in 1608 ? the date of a monument at Chadwell Spring ? but halted near Wormley , Hertfordshire , in 1610 . The stoppage has been attributed to factors such as Myddelton facing difficulties in raising funds , and landowners along the route opposing the acquisition of their lands on the ground that the river would turn their meadows into " bogs and quagmires " . Although the landowners petitioned Parliament , they did not succeed in having the legislation authorising the project repealed prior to Parliament being dissolved in 1611 ; the work resumed later that year . The New River was officially opened on 29 September 1613 by the Lord

Mayor of London , Sir John Swinnerton , at the Round Pond , New River Head , in Islington . It still supplies the capital with water today .

= = = Other mathematical work = = =

For some time Wright had urged that a navigation lectureship be instituted for merchant seamen , and he persuaded Admiral Sir William Monson , who had been on Cumberland 's Azores expedition of 1589 , to encourage a stipend to be paid for this . At the beginning of the 17th century , Wright succeeded Thomas Hood as a mathematics lecturer under the patronage of the wealthy merchants Sir Thomas Smyth and Sir John Wolstenholme ; the lectures were held in Smyth 's house in Philpot Lane . By 1612 or 1614 the East India Company had taken on sponsorship of these lectures for an annual fee of £ 50 (about £ 6 @,@ 500 as of 2007) . Wright was also mathematics tutor to the son of James I , the heir apparent Henry Frederick , Prince of Wales , from 1608 or 1609 until the latter 's death at the age of 18 on 6 November 1612 . Wright was described as " a very poor man " in the Prince 's will and left the sum of £ 30 8s (about £ 4 @,@ 300 in 2007) . To the Prince , who was greatly interested in the science of navigation , Wright dedicated the second edition of Certaine Errors (1610) and the world map published therein . He also drew various maps for him , including a " sea chart of the N.-W. Passage ; a paradoxall sea @-@ chart of the World from 30 ° Latitude northwards ; [and] a plat of the drowned groundes about Elye , Lincolnshire , Cambridgeshire , & c " .

Wright was a skilled designer of mathematical instruments . According to the 1615 Caius annals , " [h] e was excellent both in contrivance and execution , nor was he inferior to the most ingenious mechanic in the making of instruments , either of brass or any other matter " . For Prince Henry , he made models of an astrolabe and a pantograph , and created or arranged to be created out of wood a form of armillary sphere which replicated the motions of the celestial sphere , the circular motions of the sun and moon , and the places and possibilities of them eclipsing each other . The sphere was designed for a motion of 17 @,@ 100 years , if the machine should last that long . In 1613 Wright published The Description and Use of the Sphære , which described the use of this device . The sphere was lost during the English Civil War , but found in 1646 in the Tower of London by the mathematician and surveyor Sir Jonas Moore , who was later appointed Surveyor General of the Ordnance Office and became a patron and the principal driving force behind the establishment of the Royal Observatory at Greenwich . Moore asked the King to let him have it , restored the instrument at his own expense and deposited it at his own house " in the Tower " .

The Caius annals also report that Wright " had formed many other useful designs , but was hindered by death from bringing them to perfection " . The 1610 edition of Certaine Errors contained descriptions of the " sea @-@ ring " , which consisted of a universal ring dial mounted over a magnetic compass that enabled mariners to determine readily the magnetic variation of the compass , the sun 's altitude and the time of day in any place if the latitude was known ; the " sea @-@ quadrant " , for the taking of altitudes by a forward or backward observation ; and a device for finding latitude when one was not on the meridian using the height of the pole star .

In 1614 Wright published a small book called A Short Treatise of Dialling : Shewing , the Making of All Sorts of Sun @-@ dials , but he was mainly preoccupied with John Napier 's Mirifici Logarithmorum Canonis Descriptio (Description of the Wonderful Rule of Logarithms) , which introduced the idea of logarithms . Wright at once saw the value of logarithms as an aid to navigation , and lost no time in preparing a translation which he submitted to Napier himself . The preface to Wright 's edition consists of a translation of the preface to the Descriptio , together with the addition of the following sentences written by Napier himself :

But now some of our countreymen in this Island well affected to these studies , and the more publique good , procured a most learned Mathematician to translate the same into our vulgar English tongue , who after he had finished it , sent the Coppy of it to me , to bee seene and considered on by myselfe . I having most willingly and gladly done the same , finde it to bee most exact and precisely conformable to my minde and the originall . Therefore it may please you who are inclined to these studies , to receive it from me and the Translator , with as much good will as we

recommend it unto you .

While working on the translation , Wright died in late November 1615 and was buried on 2 December 1615 at St. Dionis Backchurch in the City of London . The Caius annals noted that although he " was rich in fame , and in the promises of the great , yet he died poor , to the scandal of an ungrateful age " . Wright 's translation of Napier , which incorporated tables that Wright had supplemented and further information by Henry Briggs , was completed by Wright 's son Samuel and arranged to be printed by Briggs . It appeared posthumously as A Description of the Admirable Table of Logarithmes in 1616 , and in it Wright was lauded in verse as " [t] hat famous , learned , Errors true Corrector , / England 's great Pilot , Mariners Director " .

According to Parsons and Morris , the use of Wright 's publications by later mathematicians is the " greatest tribute to his life 's work " . Wright 's work was relied on by Dutch astronomer and mathematician Willebrord Snellius , noted for the law of refraction now known as Snell 's law , for his navigation treatise Tiphys Batavus (Batavian Tiphys , 1624) ; and by Adriaan Metius , the geometer and astronomer from Holland , for Primum Mobile (1631) . Following Wright 's proposals , Richard Norwood measured a degree on a great circle of the earth at 367 @,@ 196 feet (111 @,@ 921 m) , publishing the information in 1637 . Wright was praised by Charles Saltonstall in The Navigator (1642) and by John Collins in Navigation by the Mariners Plain Scale New Plain 'd (1659) , Collins stating that Mercator 's chart ought " more properly to be called Wright 's chart " . The Caius annals contained the following epitaph : " Of him it may truly be said , that he studied more to serve the public than himself " .

= = Works = =

= = = Authored = = =

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Wright , Edward (1657) , Certaine Errors in Navigation Detected and Corrected , with Many Additions that were not in the Former Edition .. (3rd ed .) , London : J [oseph] Moxon .

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Demonstrated by Many Arguments and Experiments] , London : Excudebat Petrus Short (Latin) .
The Making , Description and Use of the Two Instruments for Seamen to find out the Latitude ... First Invented by Dr. Gilbert , published in Blundeville , Thomas ; Briggs , Henry ; Wright , Edward (1602) , The Theoriques of the Seuen Planets shewing all their Diuerse Motions , and all other Accidents , called Passions , thereunto Belonging . Now more Plainly set forth in our Mother Tongue by M. Blundeuile , than euer they haue been heretofore in any other Tongue whatsoeuer , and that with such Pleasant Demonstratiue Figures , as euery Man that hath any Skill in Arithmeticke , may easily Vnderstand the same . ... VVhereunto is added by the said Master Blundeuile , a Breefe Extract by him made , of Maginus his Theoriques , for the Better Vnderstanding of the Prutenicall Tables , to Calculate thereby the Diuerse Motions of the Seuen Planets . There is also hereto added , the Making , Description , and Vse , of Two Most Ingenious and Necessarie Instruments for Sea @-@ men ... First Inuented by M. Doctor Gilbert ... and now here Plainely set downe in our Mother Tongue by Master Blundeuile , London : Printed by Adam Islip .
Wright , Edward (1613) , The Description and Vse of the Sphære . Deuided into Three Principal Partes : whereof the First Intreateth especially of the Circles of the Vppermost Moueable Sphære , and of the Manifould Vses of euery one of them Seuerally : the Second Sheweth the Plentifull Vse of the Vppermost Sphære , and of the Circles therof Ioyntly : the Third Conteyneth the Description of the Orbes whereof the Sphæres of the Sunne and Moone haue beene supposed to be Made , with their Motions and Vses . By Edward Wright . The Contents of each Part are more particularly Set Downe in the Table , London : Printed [by E. Allde] for Iohn Tap dwelling at S. Magnus corner . Later editions and reprints :
Wright , Edward (1627) , The Description and Use of the Sphære . Deuided into Three Principall Parts . Whereof the First Intreateth especially of the Circles of the Vppermost Moueable Sphære , and of the Manifold Vses of euery one of them Seuerally . The Second Sheweth the Plentifull Vse of the Vppermost Sphære , and of the Circles thereof Joyntly . The Third Contayneth the Description of the Orbes whereof the Sphære of the Sunne and Moone haue been supposed to bee Made , with their Motions and Vses . By Edvvard Wright . The Contents of each Part are more particularly Set Downe in the Table , London : Printed by B [ernard] A [lsop] and T [homas] Fawcet for Iohn Tap , and are to bee sold at his shop at S. Magnus corner .
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Napier , John ; Wright , E [dward] , transl . (1618) , A Description of the Admirable Table of Logarithmes : With a Declaration of the Most Plentifull , Easie and Speedy Use thereof in both kinds of Trigonometry , as also in all Mathematicall Calculations . Invented and Published inn Latine by that Honourable Lord John Nepair , Baron of Marchiston , and translated into English by the late learned and famous Mathematician , Edward Wright . With an Addition of the Instrumentall Table to finde the part of the Proportionall , intended by the Translator , and described in the end of the Booke by Henrie Brigs Geometry @-@ reader at Gresham House in London . All Perused and Approved by the Authour , and Published since the Death of the Translator . Whereunto is added New Rules for the Ease of the Student (2nd ed .) , London : Printed for Simon Waterson .
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