A Regiment for the Sea, and other Writings on Navigation, by William Bourne of Gravesend

E. G. R. Taylor

THE HAKLUYT SOCIETY

A Regiment for the Sea, and other Writings on Navigation, by William Bourne of Gravesend, a Gunner, c.1535–1582

Edited by
E.G.R. TAYLOR

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BY
WILLIAM BOURNE

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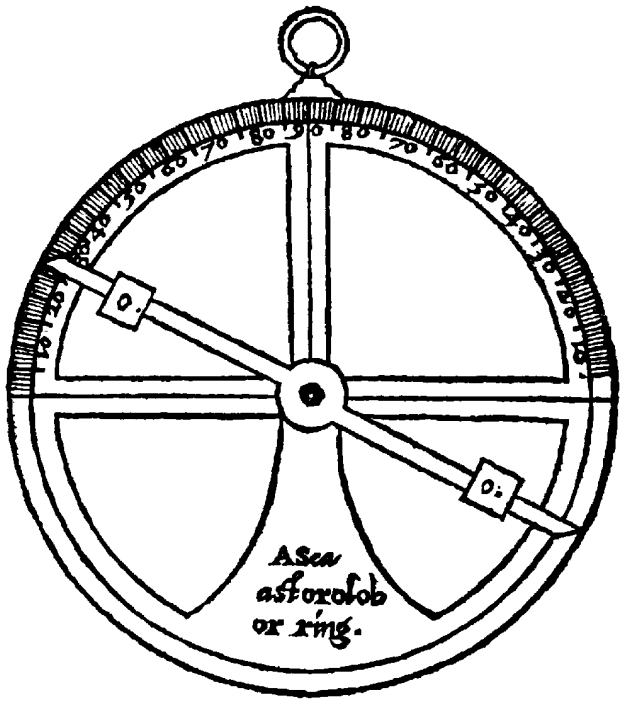

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Fig. 1. Title-page of *A Regiment for the Sea*, by William Bourne, 1574

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and other writings on navigation

by

WILLIAM BOURNE

of Gravesend, a gunner

(*c.* 1535–1582)

Edited by

E. G. R. TAYLOR

Emeritus Professor of Geography in the University of London

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PREFACE

THE interest taken today by so many people in the early history of science and technology suggested to the present editor that it would be an appropriate moment to publish among the Hakluyt Society's volumes what is perhaps the earliest technical manual written by an Englishman. The Council of the Society agreed, for it was a Seaman's Manual, fitted therefore to accompany and illuminate the histories of great sea-voyages with which the name of the Society is associated. Moreover the writer of the Manual was a contemporary of Richard Hakluyt himself, and although there is no evidence that they ever met, the great historiographer shared with William Bourne a strong and constant urge to see England great upon the sea.

As quite a young man Bourne, 'student in the mathematics', attracted the attention of Sir William Cecil, a statesman whose eagerness to encourage technical advance in this country his biographers unfortunately ignore or brush aside. And of course our author met Dr Dee, not indeed as an astrologer, but as a fellow enthusiast for trained seamanship, and the first to forecast a British overseas empire.

The book which forms the core of this volume, the *Regiment for the Sea*, is not without its romantic fringes. Bourne wrote as he spoke, so that out of his instruction book for sailors emerges a picture of the man himself, serious, reliable, patriotic, and with an inborn impulse to teach. A middle-class Elizabethan, of whom we meet too few, he also found time to serve on the town council, to keep an inn, and be a careful father to seven boys.

The editor wishes to express her deep gratitude to Mr R. A. Skelton, Honorary Secretary of the Society, for his unsparing help in preparing this book for the Press. Sincere thanks are also due to many others who have answered inquiries or supplied material, among them Lieut-Commander D. W. Waters, Mr

G. R. Crone, Dr Helen Wallis, Miss E. M. J. Campbell, Brigadier O. F. G. Hogg, O.B.E., the Borough Librarian of Gravesend (Mr E. N. Moore), and Lieut-Commander Michael Godfrey.

She is also indebted to Lord Salisbury, who courteously allowed the reproduction of two maps from the archives at Hatfield House (Figs. 3 and 15); to Messrs Methuen & Co. and Messrs Hollis & Carter, who kindly lent blocks; and to the owners of originals whose permission to reproduce is acknowledged in the list of illustrations.

Finally, mention must be made of Mrs S. J. Arthur, Mrs M. Ibbett and Mrs A. May, who expended so much care on the excellent typing of three difficult texts and miscellaneous manuscript material.

E. G. R. Taylor

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Blocks were kindly lent by Messrs Methuen & Co. (Figs. 4, 5, from E. G. R. Taylor, *Tudor Geography 1485–1583*, London 1930) and by Messrs Hollis & Carter (Figs. 7, 12, from D. W. Waters, *The Art of Navigation in England in Elizabethan and Early Stuart Times*, London 1958; and Figs. 10, 11, from E. G. R. Taylor, *The Haven-finding Art*, London 1956).

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GENERAL INTRODUCTION

WILLIAM BOURNE was a remarkable man. Born during the latter half of the reign of Henry VIII, he was to emerge during that of the first Elizabeth as the successful writer of a new type of text-book, one intended for a new type of reader. Neither a scholar nor of gentle birth, he intruded into the field of authorship which was still generally regarded as the preserve of the scholar and the gentleman. Scientific books in particular, based as they still were on ancient learning, were expected to appear only from the university, and to be read only by those who were proficient in Latin. Yet here was a Gravesend inn-keeper (for such was Bourne's status) who produced, and dedicated to various noblemen,[1] a whole series of technical manuals written in English. This daring behaviour naturally exposed him to much unkindly and scornful criticism from gentlemanly and scholarly authors. He was hurt by this, but eagerly excused himself. He was only a 'simple man', he declared, and his books were not intended for the 'learned sort'. They were meant only for 'meaner men' to read, men who at present were utterly ignorant.[2]

Bourne addressed himself, in fact, in the first instance to the skilled artisans and master-craftsmen who were his own friends and neighbours. These were the men whom, because of his own mathematical bent, because, too, of a strong personal impulse, he was so eager to instruct. And he justified himself by recalling 'the opinion and sayings of the sage and auncient Writers, that one man should be an instructer to another'; a tag he had possibly picked up at school.

[1] His principal patron was Edward Fiennes, Lord Clinton (1512–85), who was first appointed Lord Admiral in 1550–1554, and created Earl of Lincoln in 1572 (Fig. 7).

[2] In a manuscript *c.* 1573 (see below, p. xxvi), he wrote: 'To ye gentell reder: I praye you hold me excused, I being alltogether ignorante, lacking the capacitye bothe of knowledge and experience have taken upon me . . . to open any scyence.'

The social changes, particularly the increase of literacy (fostered by the grammar schools) and the many advances in technology, which characterized Tudor England, had created the need for a new class of mathematical books. These had to be simply written, knowledgeable, and above all practical. Yet in this country books of such a character were up till then wanting. They were of a kind that neither the scholar, isolated in the narrow circle of the university, nor the cultured gentleman, secluded in his library, had the necessary gifts and experience to write. Their potential readers, the master shipwright, the ship-master, the master-gunner, for example, were on the other hand the very people whom Bourne met, and knew, and saw at work, every day. Such men were remote indeed from the literary world, but here was an individual who believed that he could give them the particular knowledge that they needed — mathematical rules instead of the customary rule of thumb, academic learning couched in homely style to correct or supplement their traditional lore.

A demand for new writing in the vernacular had already been voiced in England quite early in the sixteenth century. It came from the humanist circle gathered round Sir Thomas More. His brother-in-law John Rastell had expressed it pungently in his *New Interlude*:

> . . . divers pregnant wits be in this land
> As well of noblemen as of mean estate
> Which nothing but English can understand.
> Then if cunning Latin books were translate
> Into English, well correct and approbate,
> All subtle science in English might be learned.

Whether in direct response to this appeal or no, Dr Recorde, the Welsh scholar and university teacher from Tenby, did publish a valuable set of text-books in English between 1542 and 1557. These works made it possible for any intelligent man with the ability to apply himself to master a group of subjects which are

basic to all science: arithmetic, plane geometry, and the geometry of the sphere. The books appeared during the years in which Bourne was growing up to manhood, and he undoubtedly read and mastered them. And in addition, like many other middle-class youths, he was powerfully influenced by the first English writer to attack the problem of mathematics for the artisan — Leonard Digges.

Digges was a gentleman of East Kent and a university man. He is first heard of expounding geometrical principles (with practical demonstrations drawn from gunnery), among a group of friends on the bulwarks of Calais in 1542. Many people must already have begun asking the question: why should we English have to employ an Italian engineer to build our fortresses? Or, why must we engage a Spanish, or a Portuguese, or a French pilot to take our ships across the ocean? Or again, why should we have to buy our marine charts in Lisbon, our globes and maps in the Low Countries? Digges had realized that the answer was the same in every case. These foreigners knew how to apply geometry to mensuration, they could read mathematical tables, they could construct and handle mathematical instruments. But our people knew nothing of such things. The instructions for carrying out mathematical practices, the methods of computing mathematical tables, the designs for making mathematical instruments, all were as Digges phrased it, 'locked up in strange tongues'.[1] This had, of course, been no hindrance to Leonard himself. As a scholar, he could read the books of the German Peter Apian, of the Italian Nicholas Tartaglia, of the Fleming Gemma Frisius, and of the Frenchman Orontius Finaeus. And that whether they wrote in Latin or each in his native tongue. All these men were already teach-

[1] William Cuningham was to write his *Cosmographical Glasse* (1559) in English, and he dedicated it to the Earl of Leicester. Robert Dudley very probably was not at home in Latin, but as a young man he had shown himself very interested in applied mathematics. Cuningham's style, however, was unsuited to the artisan reader, who could hardly see himself as Spondaeus conversing learnedly with Philonicus, although there was much that was relevant to Navigation in the book.

ing their compatriots ways of applying mathematics to gunnery, to navigation, to surveying, to cartography and cosmography, to horology. Furthermore they all concerned themselves directly with the design and construction of mathematical instruments. It was ironical that when Leonard Digges had succeeded in putting some of the more elementary parts of their teaching into two small English books — called respectively *A Prognostication* (1553) and *Tectonicon* (1556) — he had to employ a Flemish immigrant to print them, as well as to make the instruments he there described. This man was Thomas Gemini,[1] best known perhaps as a fine engraver, but also practising as an instrument-maker and cartographer. Digges's career, unfortunately, was brought to a close in 1554, when he joined in Wyatt's rebellion. He was attainted, deprived of his estates, and exiled. But his *Prognostication* (which included a Kalendar) continued to be reprinted through the century. William Bourne studied *Tectonicon* carefully, and concluded that he had something to add to it. But as everything that he wrote was closely bound up with his personal circumstances, these must first be examined.

Gravesend, where William was born, lived and died, had long been an active and important port both for river and sea traffic as it still is today.[2] Situated on the southern or Kentish bank of the river Thames, it lies 26 miles below London Bridge and 21 miles above the Nore Lightship where the wide estuary begins. Not very far up-river there then stood Greenwich Palace, where Queen Elizabeth held Court, while about ten miles downstream was the mouth of the river Medway, within which the Royal Navy lay at anchor, guarded by Upnor Castle. Much of the lower Thames is bordered by marshes which until reclaimed were liable to flood, but here and there the compact, porous chalk, of which the Kentish Downs are built, comes down to

[1] E. G. R. Taylor, *Mathematical Practitioners*, p. 165.

[2] R. P. Cruden, *The History of the Town of Gravesend* (1843). The author reproduces all the surviving documents in which William Bourne's name is mentioned, and his book is a main source for the activities of Gravesend described below.

the water's edge, and even reappears on the opposite Essex bank of the river. At such points, there is well-drained land rising above flood-level, and since earliest times this firm ground has provided convenient sites for settlement. It is on one of these 'rises' that Gravesend was built, just below Erith marshes, with the two Tilbury villages facing it across the river, also built on the chalk outcrop.[1] Behind Gravesend the old Roman road between Dover and London passes within a mile or two, and as, prior to the making of the toll-roads, the safest and most comfortable way of travel was by water, much incoming traffic was transferred to the river at this point. Similarly, outgoing traffic from London only left the Thames at Gravesend where it took the road. The much-frequented stretch of water between Gravesend and Billingsgate Stairs in the City of London was known as the Long Ferry. Ever since mediaeval days traffic over it had been provided by a carefully organized service of barges or wherries. These vessels went up on the flood-tide and came down on the ebb, and were consequently known as Tide Barges. The daily tidal time-lag meant a daily change of time-table, and departures were cried in the streets. The people of Gravesend must have been sharply aware of the 'age of the moon', which governs the hour of the tides. This was certainly the case with William Bourne, as his books demonstrate.

The running of the public barges was reserved to the citizens of Gravesend, and the ownership of a 'Tide', or place in the rota of sailings was a valuable property which was passed on from father to son, as in Bourne's case. While no poaching was allowed on the general traffic in passengers and goods to which the tide-barge owners had the first right, there were also wherries and tilt-boats for private hire. The latter provided luxury transport for the nobility and gentry when they used the Long Ferry.

But river traffic was not the only business centred on

[1] See Symonson's map of 1596 (Fig. 2).

Gravesend. The port was reckoned the last 'creek' of the Port of London, and here all the customs formalities had to be gone through by the masters of ships putting out to sea. The 'searchers' came aboard to examine the holds, and the 'cockets' of relevant ship's papers were handed over to them for inspection. At Gravesend, besides, the master had to send to Dover or Harwich for the Trinity House pilot whom he was obliged to employ to take him out of the estuary — a stretch of water remarkable for its intricate channels and shifting sandbanks. Since it might also be necessary to wait on wind and weather, it can be well understood that ships outward bound were anchored before Gravesend for periods from at least a couple of days up to several weeks. As a consequence the town was full of ale-houses and inns where the sailors spent their waiting time, while the ship's officers and petty officers would bring their women-folk so far before they said goodbye.

A famous occasion (described by Richard Hakluyt[1]) which William Bourne must have witnessed as a young man, was the departure of the third Muscovy expedition in 1556. Sebastian Cabot, then Governor of the Muscovy Company, brought a party of ladies and gentlemen down to Gravesend to look over the *Searchthrift*, a pinnace that was being taken to explore the Arctic shore of Russia that summer. Stephen Borough was her master designate, while his brother William was to serve as mate. Richard Chancellor, discoverer of the White Sea route, was Captain and Chief Pilot of the four 'great ships' of the fleet. It was to prove his last voyage. The Boroughs entertained the party on the pinnace, and afterwards Cabot gave them all a return banquet ashore at the Christopher Inn. This was the occasion when Sebastian astonished everybody by joining in the dancing, for he was a very old man. And like Chancellor he was soon to die.

It can hardly be doubted that William Bourne had also been among the spectators, three years earlier, at the setting out of

[1] Richard Hakluyt, *Principall Navigations* (1589), p. 311.

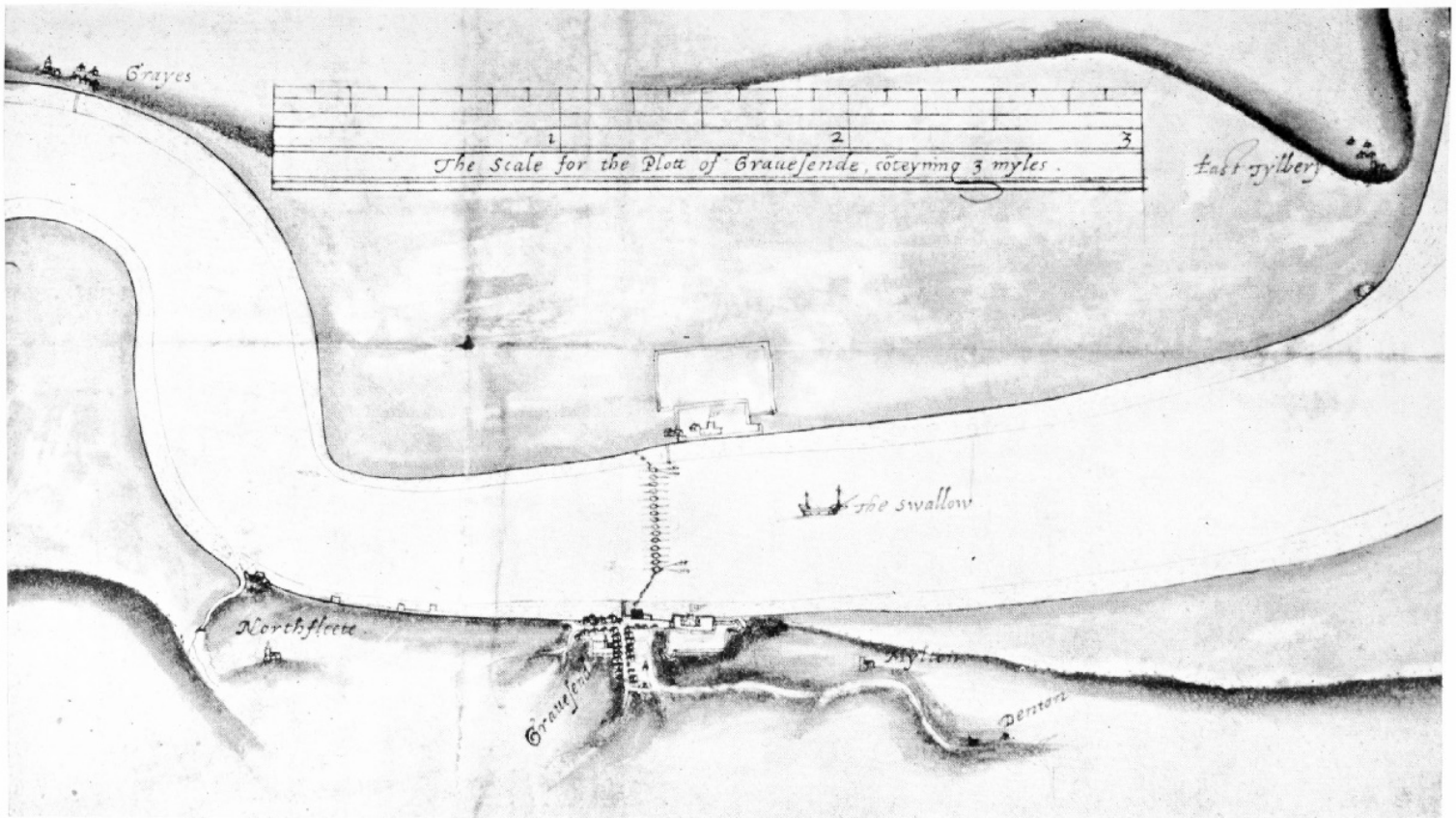

Fig. 3. Gravesend and Tilbury Bulwark: inset of William Borough's MS chart of the Thames, 1596

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the very first fleet bound for the North-east Passage. The ships had anchored before Gravesend after being towed in state past Greenwich Palace, where the young King Edward, for whom the spectacle had been arranged, actually lay dying. Chancellor and the two Boroughs were all serving in the *Edward Bonaventure*, but the younger brother was then still an apprentice before the mast. Some twenty-odd years later Bourne's own step-son was to leave Gravesend to sail for the North-west Passage with Frobisher. If William himself never went to sea there was yet little he did not know about the ways and needs of sailors.

But ships and sailors, customs officers and pilots, shipwrights and ship-chandlers — the whole business of the river and the sea — still did not add up to the whole sum of influences brought to bear on a young man growing up at Gravesend. Where the town stood the Thames was barely eight hundred yards wide, with a firm footing on either bank. Henry VIII chose it as the site for the fortifications designed to defend London against attack from the sea. Bulwarks, i.e. small forts and ramparts, were built in 1539 in Tilbury parish in Essex and also at Gravesend. The small permanent garrisons attached to them[1] required to be supplemented by the citizen soldiery in times of emergency.[2] The bulwarks were mounted with cannon, and William Bourne had trained and prepared himself to do service as a gunner — 'your poore gunner' as he describes himself to Sir William Winter, the Queen's Master of Ordnance.[3] He lived, in fact, in the immediate company of

[1] According to an early (undated) document of Queen Elizabeth's reign setting out the Queen's *Annual Expence*, the establishment at the two Tilbury forts was two captains, two porters, six soldiers, five grooms and an unspecified number of gunners. At Gravesend there were a captain and porter, two soldiers and five grooms. A gunner's pay was sixpence a day. A captain had one shilling. The document is printed in Francis Peck's *Desiderata Curiosa* (1779).

[2] In the Gravesend Register of Deaths a Mr Jasper May is described as a shipwright and 'one of the Gunners of Gravesend Bulwark' (Cruden, p. 211).

[3] William Winter (1525?–1589), Master of Ordnance of the Navy 1557, knighted 1573.

soldiers as well as of sailors, and both groups, to his mind, were urgently in need of professional instruction. Such instruction he himself, as a 'Student of the Mathematicks', was able to provide, and indeed had a duty to provide, so he believed.

Of Bourne's early life little is known, save for the cardinal fact that he was born into the small group (comprising little more than fifty individuals) who were reckoned the 'capital inhabitants' of Gravesend. His father, John Bourne, was the owner of house-property which he remaindered to his unborn grandsons. He died in 1560, and two years later, when Gravesend received its first Charter of incorporation, William was appointed one of the jurats, or town councillors. His name appears in several later lists of jurats (e.g. in 1568 and 1573), while in 1571–2 he served a term as port-reeve, the equivalent of mayor. His mother was still living in 1573, and it appears probable that he was an only son, born about 1535. He died early in 1582,[1] but the fact that his very brief Will[2] was drawn up in 1573 suggests that he suffered a serious illness at that time, since a Will was usually made only in immediate expectation of death or before some dangerous journey.

As his Will indicates, Bourne was by that date a married man, the father of four little boys, about whose schooling he was concerned. He had chosen as his wife a Mistress Dorothy Beare, a local widow, who was apparently also well-to-do. She was already the mother of three well-grown sons, whose names later appear among the 'capital inhabitants' of Gravesend. The two elder, Samuel and John Beare, were each in turn to serve terms as port-reeve, as did Bourne's own son Richard when he came to manhood. Like Bourne himself the Beares had an interest in the Long Ferry, while the youngest brother, James, was apprenticed to the sea, where he had a long and

[1] The Gravesend Register has the entries: '1582 March 22nd was William Bourne a householder buried,' and 'Dec. 13th was Dorothie Bourne, widow, buried' (Cruden, p. 212).

[2] See below, p. 435.

distinguished career.[1] Since he was old enough to hold the office of Master of a ship in 1577, while his brother John had been made a freeman of Gravesend in 1572, it is reasonable to conclude that Mistress Beare's first family were born not much before or after 1550. Her marriage to Bourne can hardly have been before 1565, for none of the younger children had come of age before they lost both parents at a few month's interval in 1582. The only daughter, Marie, had not been born in 1573 when William made his Will, and this little girl was her mother's first concern when on her death-bed she dictated her own Will to the curate of Gravesend.

It is from Dorothy Bourne's Will[2] that we learn something of the style and comfort in which the family lived. They kept several servants. The best bed was hung with silk curtains, there was silver plate for the table; besides a housewifely store of linen, and some good pieces of furniture. A number of handsome garments of her late husband's, besides her own rings, went to Dorothy's grown sons, while her personal clothing was to be divided among her three daughters-in-law. Little Marie was placed in the custody of John Beare, who was appointed executor of the Will. The overseer was Edward Darbyshire. This man must have been the most prominent of Gravesend's citizens. He was three times port-reeve and lived in what was described as a 'mansion-house'. No doubt he was a family friend. The 'capital inhabitants' of the port formed a close-knit intermarrying group. Bourne's share in the Long Ferry took the form of two 'half-Tides' in which his partners (owning the

[1] James Beare died in 1609. His monument (now destroyed) in Gravesend Church showed five sons and five daughters, and his epitaph (Cruden, p. 221) ran:

> 'After much wery sayling, worthie Bere
> Arryved this quiet port, and harbers here.
> As skilfully in honestie he brought
> His humaine Vessel home, as he was thought
> Equall with any that by Card or Starr,
> Took out and brought again his Barke from far.
> So let him rest in quiet. . . .'

[2] See below, p. 436.

other 'half-Tides') were two cousins, Clegant and Warde, whose family names appear several times in contemporary Gravesend records. Since the Tides were passed from parent to child, there is a suggestion here of a common grandparent.

That William Bourne was an inn-keeper we learn from the appearance of his name in a list of persons fined for small breaches of the regulations under which beer was sold. It was during his year of office as port-reeve. The same list contains the name of William Morris, at whose inn the farewell party took place in 1582 when Captain Luke Ward sailed from Gravesend to join Captain Edward Fenton on the voyage intended for Cathay by the Cape Route.[1] The date was only two months after Bourne's death, and the chaplain of the fleet, Richard Madox, carried a copy of his *Regiment*, the book that is printed here.

How and when William Bourne began his career as a mathematical instructor and writer (a 'practitioner' as they called themselves), must be largely a matter of inference. There was rarely any mathematical teaching in the grammar schools. Boys intended for business were sent to the writing-master, from whom, in addition to acquiring a clerkly hand they learnt simple arithmetic and the keeping of accounts. Such was the training which the Muscovy Company provided for little Nicholas Chancellor after his father, Richard, was drowned in 1556. A successful master often put his teaching notes together into a published book, although some went no farther than selling hand-copied sets to their pupils. It was for long the custom for them to refer to these pupils as their 'friends', so that it was not unusual for an author to say that his book appeared owing to the persuasion of his friends.[2] The artifice

[1] See E. G. R. Taylor (ed.), *The Troublesome Voyage of Captain Edward Fenton* (Hakluyt Society, 1959).

[2] In the preface to his *Maner and fourme how to kepe a perfecte reconyng* (1553), James Peele writes: '... many which have liked this my peines and diligence herein, have required me, that every good thyng, the further it goeth, the better ... I therefore ... have endevoured (to my small powers) not only to satisfie the request of my said

was exposed by a blunt Scottish teacher, John Wilson, in 1714, who openly said that he produced his text-book 'for the genetlemen who attended my lessons'.

A writing master, of course, did not go far enough into mathematics to satisfy gentlemen who wanted to understand the military art — range-finding, tunnelling, or the use of siege-engines — nor could he serve the purposes of the country gentleman who desired an elaborate sun-dial or a scale-plan of his estates. Such a client called a 'mathematical practitioner' into his chamber, or even made one a member of his household, where he might also act as tutor. Thomas Digges publishing his late father's manuscript teaching manual under the title of *Pantometria*, recalled the 'conferences' on the subject matter which Leonard had held with Sir Nicholas Bacon to whom the printed book was now dedicated. John Dee, the intimate friend of Leonard Digges, was at about the same time teaching military mathematics to John Dudley, one of the Earl of Northumberland's sons, a young man whose early death in 1554 he was soon to deplore.[1]

The custom arose for such a mathematical practitioner to advertise his skill indirectly by publishing an '*Almanack and Prognostication*', as Leonard Digges did in 1553. Indeed by the early seventeenth century such Almanacs often contained advertisements openly soliciting pupils, and giving a résumé of the author's teaching syllabus. But in the sixteenth century, at least in Bourne's lifetime, this was not so. There was greater reticence. The ordinary public thought of the Almanac maker chiefly as an astrologer, a man who could be asked to name fortunate and unfortunate days for domestic and business

frendes, but also the greate lacke and nedefull instruction, whiche many have wanted in their accomptes'. Another well-known writing-master of the day was John Mellis, who lived 'at Mayes Gate, nie to Battle Bridge in the parish of Southwark', and was the author of *A Shorte & plaine Treatise of Arithmeticke in whole numbers*. A third was Humfrey Baker, who in 1558 translated *Les Canons et documens tresamples, touchant l'usage et practique des communs Almanacks* written by Oronce Finé for the instruction of the unlearned.

[1] E. G. R. Taylor, *Tudor Geography*, pp. 89, 191.

transactions, or could cast the horoscope of a child. Digges, however, although he defended astrology, took a step forward when he added to his *Prognostication* a number of Tables, notes, and diagrams likely to prove of special interest to seamen and artisans. Bourne followed this example when he published his first *Almanack and Prognostication* in 1567. He deprecated astrology but offered to the reader an addendum in the shape of *Serten Rules of Navigation* which in effect comprised a little Sea Manual. It is likely that he had begun to teach applied mathematics some years earlier, for the monthly Kalendar which he now printed was one which contained the movable feasts for 1564. The Almanac (as distinct from the Kalendar) gave the dates of the phases of the Moon through the months and was correct for the years 1571–3 (found in the second edition, of which alone complete copies have survived) and was presumably correct also for the years 1567–9 in the first of the two editions. In 1574 William 'put to print' (as it was expressed) his principal work, the *Regiment for the Sea*, which contained a new Kalendar, besides a number of Tables, for the years 1574–7. Subsequent editions carried the Tables on until 1580, when he prepared his second *Almanack and Prognostication*, which was for the ten years 1581–90. These three works — the two *Almanacks* and the *Regiment* — are here printed in full, and will presently be discussed in more detail.[1] Meanwhile a return will be made to a consideration of such biographical facts as can be learned from Bourne's other writings.

A manuscript pamphlet of his survives[2] which was written at the request of Lord Burghley, whom he there addresses under a title (Lord Treasurer) which was not appropriate until September 1572. Its subject was Optics, and in particular the properties and capacities of mirrors and lenses. In it the writer states as his final conclusion that what Thomas Digges had claimed with regard to his father's experiments with perspec-

[1] Pp. 1, 135, and 321.

[2] British Museum, Lansdowne MS 121. Printed in J. O. Halliwell, *Rara Mathematica* (1839).

tive glasses was probably correct. Now the description which the younger Digges had given of Leonard's 'seeing at a distance' was to be found in the book called *Pantometria* which was published in 1571.[1] It seems likely, therefore, that Burghley's conference (his second one) with Bourne and his request for written information about reflecting glasses and lenses were the result of his reading this book. In his opening paragraphs Bourne declares that he had been unable to pay as much attention to optical experiments as Dr Dee and Thomas Digges had done partly because of his 'great charge of children'. This was a favourite excuse of the day for any remissness, but it adds weight to the suggested date 1572, since the writer then had his own four little boys to care for, while his three step-sons were just emerging into the adult world.

If this date is accepted, then an earlier conference with Lord Burghley, which is mentioned as having taken place seven years ago, can be put at about 1565. This had been the outcome (so Bourne says) of the great statesman's perusal of a little manuscript which the Gravesend inn-keeper had sent him. This paper (now lost) dealt with the buoyancy of water, for the fact that a ship lay a few inches higher in salt water than in fresh was one of great importance to seamen when (say) crossing a bar. It would naturally be observable when ships came into the Thames, since a ship was marked with a load-line. After this conference Bourne wrote what he called a 'little book of Static' (also lost), which dealt more widely with the measurement of a ship's capacity and displacement. This, he now said, had proved very useful to local shipwrights, which suggests that he had circulated written copies of it to 'friends'.

The book of static, further enlarged and improved, is next to be found as part of a comprehensive manuscript which Bourne prepared and dedicated to Lord Burghley at a date which

[1] 'My father . . . hath by proportionall Glasses duely situate, in convenient angles not onely discovered things farre off. . . .' The claim is repeated in much the same terms in the same writer's *Stratioticos* (1579).

cannot be later than 1573.[1] The formal Dedication to the Lord Treasurer under his full titles, the Preface to the Reader, the many illustrations, and the inclusion even of a rhymed head-piece and tail-piece,[2] all point to this manuscript having been prepared with an eye to the press. It was customary to offer a manuscript first of all to a patron, but in this case patronage (usually in the form of a monetary gift) was apparently not secured. The material of the work was therefore reorganized and divided into two separate books which the author in 1574 promised his readers they should have if they showed appreciation of the *Regiment for the Sea*. This proved to be forthcoming, for the *Regiment* [i.e. Rule] *for the Sea* was indeed welcome as providing a complete English seaman's manual. It embodied and improved upon the 'Rules' that had been attached to the *Almanack* of 1567 and that of 1571. As will presently appear, both *Rules* and *Regiment* sprang in part from Bourne's critical attitude towards an English translation of a Spanish sea-manual which had been published in 1561. For the moment, however, it may merely be noted that he must have been playing the role of instructor to navigators as well as instructor to the ships' carpenters and 'naupagers' (as he called the shipwrights) during the mid-sixties. The first part of the manuscript unsuccessfully offered to Lord Burghley about 1573 was, however, mainly concerned not with ships but with gunnery and the associated military arts. Besides the actual handling of ordnance, the soldier, if an officer, had to master the geometrical determination of heights and distances, the scale survey of the terrain and so forth. Bourne was clearly prepared to instruct

[1] British Museum, Sloane MS 3651.

[2] Head-piece: Nothing so base boot vantage you may wyn,
Nothing so smalle boot som gayn ys ther in
Then rise you all and tacke of ye beste
Excepte my good wyll though you lyck not ye rest.

Tail-piece: Yt hath bynne seene and knowne yt knolledge dyd availle
boot now in these dayes money doth prevaylle
Yet on ye eand yf you marck yt well ye worlld is so frayll
that knoledge shall prosper when yt money shall faylle.

the soldier equally with the sailor, the land-surveyor as well as the carpenter.[1] He covered, in fact, what came to be the standard range of the so-called 'mathematical practitioner' with the exception (curiously enough) of horology, which at that time meant the geometry of sun-dials.

A very few years showed the *Regiment* to be an assured success, and by 1578 Bourne had found important patrons for the manuscript material which he still had in hand. The first part, entitled *The Art of Shooting in Great Ordnance*, which was almost directly borrowed from the Italian work of Nicholas Tartaglia, he dedicated to the Master of the Queen's Ordnance, Sir William Winter. The second part, *The Treasure for Travellers*, which dealt with mensuration, mathematical instruments, survey, and kindred matters had as patron Ambrose Dudley, Earl of Warwick, who was General of Ordnance.[2] To both these high artillery officers Bourne described himself as a gunner. In the same year he published a miscellany of notes which he entitled *Inventions and Devices*.[3] This contained various suggestions for military and nautical strategic and tactical tricks, improvements, and novelties. Again it was largely derivative. There can be no doubt that Bourne had read Tartaglia's *Quesiti é Inventioni* and Jacques Besson's *Théâtre des Instruments*, but his was the first of such books to appear in English. An interesting point for sailors was the mention of a mechanical (geared) log for measuring a ship's way, which Bourne said Humfrey Cole had made.[4] Cole was the successor to Gemini as the leading instrument-maker in England, but the device was one that Besson had already pictured in his book.[5]

[1] See Fig. 6, Bourne's survey of part of the Thames.

[2] For illustrations of Bourne's survey methods, see Figs. 5, 6.

[3] This work was dedicated to Lord Charles Howard, later to become Lord High Admiral, but it had evidently been originally offered in manuscript to Lord Clinton. 'The thing is such as you have already seen the written copy at my good Lord and Masters hande, the Earle of Lincolne,' wrote Bourne.

[4] Taylor, *Tudor Geography*, p. 171. Bourne says: 'The deviser of this Engine or instrument [No. 21] was Humfrey Cole.'

[5] Richard Eden who was a personal friend of Besson comments on this device as follows: 'By whiche description, some do understand that the knowledge of the

The Frenchman had also shown a geared carriage in which a land surveyor could ride while he read from a dial the distances that he had covered in each direction. But, in fact, the mechanical difficulties involved in making self-registering instruments of this kind either accurate or reliable were still insuperable. Bourne nowhere suggests that they were really in use.

The conclusion cannot be escaped (since so large a part of his writing was derivative) that this Gravesend burgess could read and understand the works of Italian and French authors. But there is no information available as to when or how he mastered foreign languages, nor is it known what general schooling he had had when a boy. He clearly had access to many books, and in the Preface to his *Almanack* of 1581 (written in 1580) he is able to quote from North's translation of Plutarch's *Lives* published only the year before. But there is nothing either in his own Will or that of his widow to suggest that he had formed a library. It is possible that (like Hakluyt) he was allowed the run of some gentleman's library. However that may be, it is clear that between the dates of publication of his first *Almanack* (1567) and his *Regiment for the Sea* (1574) he had studied to some purpose two important English books. The first was Sir Henry Billingsley's English translation of Euclid's Elements, to which Dr John Dee had written a lengthy *Preface* (1570). This *Preface* profoundly influenced several generations of 'mathematical practitioners'. It set out in clear and persuasive language the

longitude might so be founde, a thynge doubtless greatly to be desyred, and hytherto not certaynly knowen, although *Sebastian Cabot* on his death bed tolde me that he had the knowledge thereof by divine revelation, yet so, that he myght not teach any man. But I thinke that the good olde man, in that extreme age, somewhat doted, and had not yet, even in the article of death, utterly shaken off all worldlye vayne glorie. As touchyng whiche knowledge of the longitude, to speake a little more by occasion now given, it shal not be from the purpose, to rehearse the saying of that excellent learned man Johannes Fernelius, in his incomparable booke *De abditis rerum causis*. . . . "We have put our helping hands to the Art of Navigation & Geography, for by observation of the houres of the Equinoctial, we have invented how, in whatsoever region or place of the worlde a man shalbe, he may know in what longitude he is." ' R. Eden, *A very necessarie . . . Booke concerning Nauigation* (1578), Epistle Dedicatorie The principle that longitude difference was to be measured by time difference was familiar to astronomers. It was the means of application that was lacking.

basic relationship which arithmetic and geometry bore to each and all of the Arts, Crafts and Sciences. These in their turn were the basis of the country's prosperity. The whole argument was then summarized in tabular form so that the navigator, the land-surveyor, the horologist and other technicians could see their place in the whole scheme of applied mathematical knowledge.[1]

Dee was to become personally known to William Bourne. Esteemed the greatest English mathematician of his day, he had been adviser to the Muscovy Company on matters of navigation since it was first founded. In this very Preface he recalls that he had instructed its chief pilots, Stephen and William Borough.

The second book that Bourne studied with as much care, although with less enthusiasm than the first, was Thomas Digges's edition of his father's *Pantometria* (1571), to which reference has already been made. Although the book deals in the main with such military matters as ground-survey and range-finding, it is best known to-day for its description of a simple instrument for taking a simultaneous observation of the bearing and elevation (i.e. the azimuth and altitude) of a distant object. The instrument became known as a theodolite (at first spelt theodelite), and was immediately popular among land-surveyors. Bourne had used the old-fashioned circular plate,[2] a simplification of the back-plate of the astrolabe, into which a little magnetic needle was inserted. He gives a specimen of a survey which he had made from a base line near Gravesend — the earliest known example of an actual piece of what is termed triangulation.[3] It appeared in the manuscript already referred to as offered to Lord Burghley in 1573, and was printed in 1578 in the *Treasure for Travellers*. It is a very crude piece of work — there was no careful ground measurement of the base-line for

[1] The scheme culminated in 'Archemastrie': 'This Arte tendeth to bryng to actual experience sensible, all worthy conclusions by all the Artes Mathematicall purposed.' See Taylor, *Mathematical Practitioners*, facing p. 432.

[2] See Fig. 4. [3] See Fig. 5.

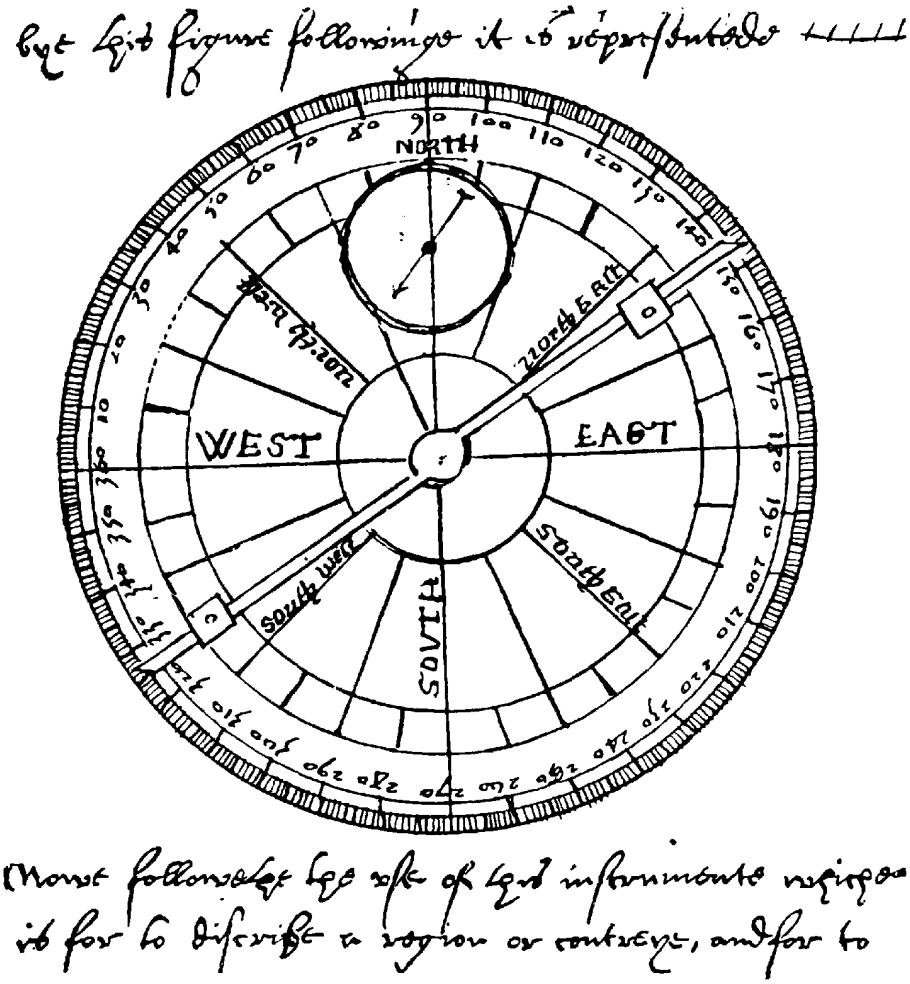

Fig. 4. William Bourne's surveying instrument
B.M., Sloane MS 3651, fol. 65

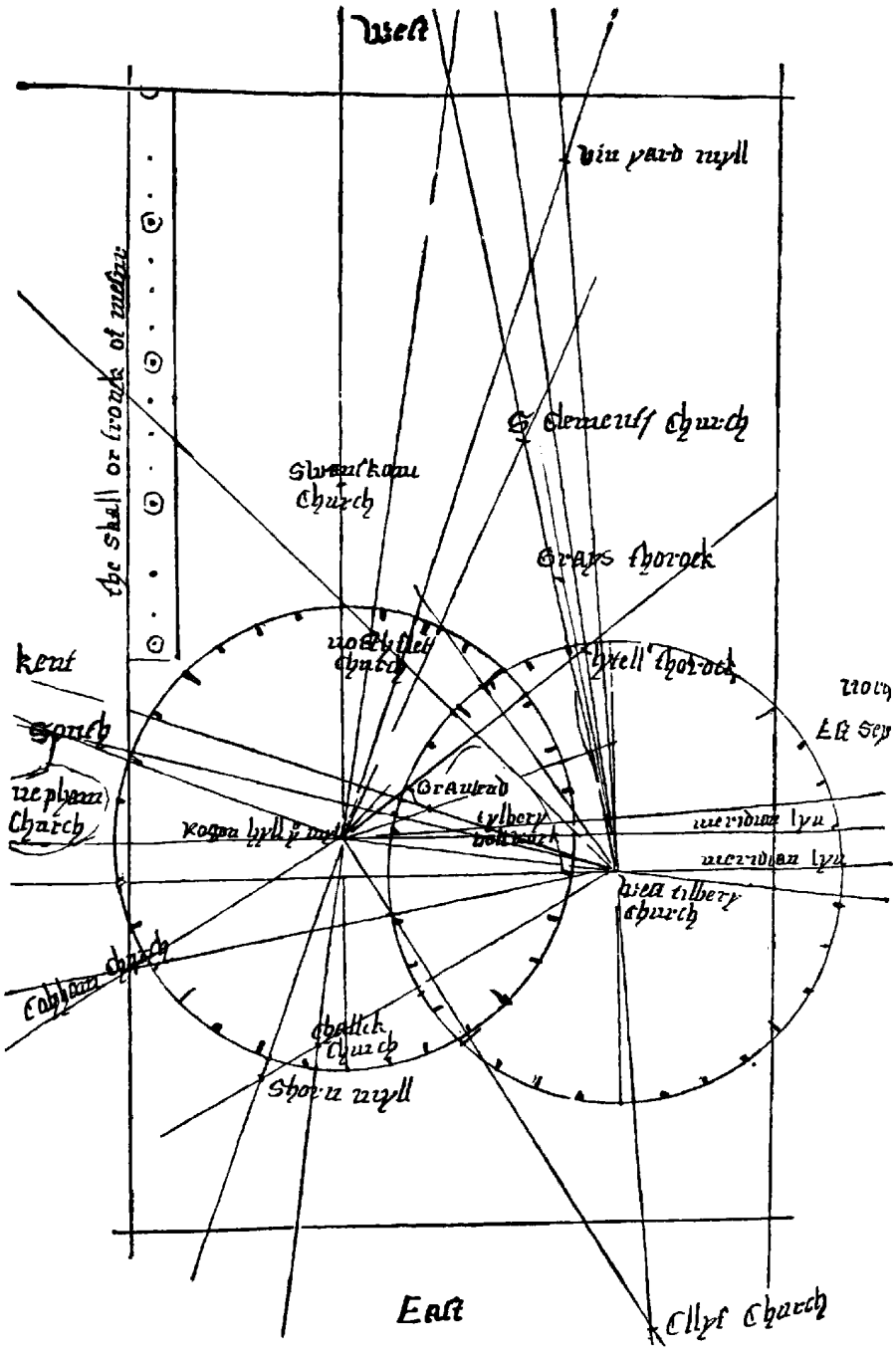

Fig. 5. Bourne's triangulation round Gravesend and Tilbury

B.M., Sloane MS 3651, fol. 68v

example — but it is a useful reminder that practice was indeed a normal accompaniment of Bourne's teaching. As one of the writers of laudatory verses prefixed to the *Regiment* states:

> Thou hast besides all this the truth
> By practise truly tride . . . [p. 145].

Whether Bourne knew Digges personally must be a matter of conjecture, but it seems unlikely. A scholar and a gentleman (he was eventually 'restored in blood' by Queen Elizabeth after his father's death),[1] and also a Member of Parliament, it is fairly certain that Thomas was among the critics of the presumptuous citizen-gunner of Gravesend who intruded into the world of books. Dee, on the other hand, welcomed all sorts of visitors, and Bourne (writing in 1580) relates his conversation with 'the great learned man' at Mortlake, when his host showed him a passage from Marco Polo bearing upon the point they were discussing.[2]

In 1579–80 he is known to have been residing at Upnor Castle on the Medway, an establishment which was an 'outpost' of the Office of Ordnance, then in the Tower of London. Queen Elizabeth had built the castle in 1564 to defend her Navy (the 'Queen's Ships') which lay at Chatham, a short distance below Rochester Bridge. Bourne was presumably in residence as a train-band master-gunner. There was a Spanish fleet at sea in 1580, helping the Irish rebels, and it may be that a surprise attack was to be feared during this period of 'cold war'.

While he was at the Castle Bourne prepared a memorandum on the means to ensure the safety of the Navy when it lay in harbour. He complains that he is unlikely to command the

[1] In his *Stratioticos* (2nd ed., p. 359) Thomas Digges says that his father 'having bene long debarred his owne inheritance and native Soile, being restored ment then immediately to return to his wonted places of Exercise . . . So sithence his death . . . by continuall Law Brables . . . I have for many yeares been so vexed and turmoiled . . .'. This suggests that Leonard died before his return to England, or immediately after it.

[2] See p. 313

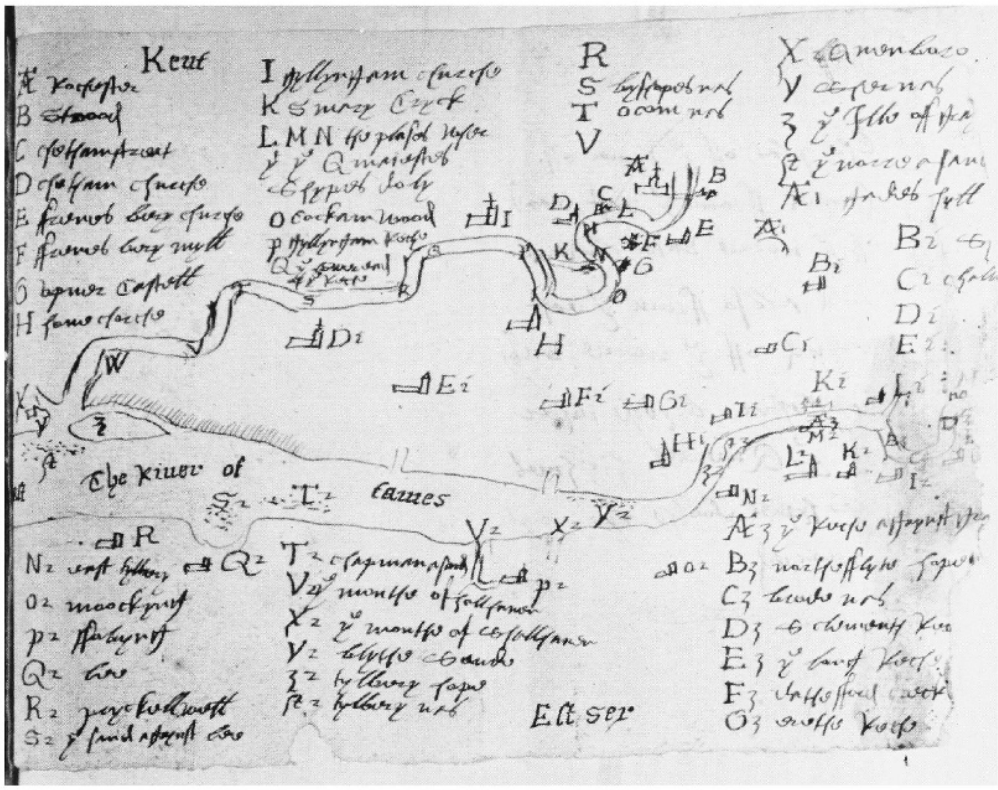

Fig. 6. 'The plat off y^e Ryuer of Tames', by William Bourne

B.M., Sloane MS 3651, fol. 74v

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attention of the authorities, since he has no status,[1] and it is worth notice that Thomas Digges had written an essay about the same time (but a very poor one) on the same theme of the possible invasion of Kent and elsewhere.[2] This was appended in 1590 to his *Stratioticos*. Digges's patron was Leicester, whose attention he could command as well as that of Lord Burghley. Bourne's special point was that it was fallacious to trust to heavy ordnance to repel invading ships. Their sails and rigging could be damaged by the cannon-balls, but they would not be sunk. A chain across the river would be a greater safeguard, and he quotes from his *Inventions and Devices* (1578) the stratagems that could be employed once the enemy was checked by the chain.[3] From the same book he cites the means by which the enemy might shield his ships from gunfire off Portsmouth, which others had suggested was a suitable port for laying up the Queen's Ships. The new fortifications (on which Richard Popinjay, Master of Works, was now engaged there) would, he said, provide no safety.

The *Inventions and Devices* was the third of his books to be published in 1578, and the manuscript had originally been offered to the Lord High Admiral, Clinton, who had earlier accepted the dedication of the *Regiment*. The Earl of Lincoln had, however, merely shown it to Lord Charles Howard, and it was the latter who accepted the Dedication. Clinton, however, lent his name to what was to prove Bourne's last book, the *Almanack and Prognostication for Ten Years* which was completed at Upnor Castle in December 1580. The fact that, in the

[1] 'All thogh y^{t} I have not to doe, nether no person doothe aseke me y^{t} questione, thynkynge me to symple in soche waytie affaires, y^{t} ys to say in those Corses y^{t} doothe Concerne y^{e} statte & preservation of . . . ye holle navie. . . .' *A Dyscourse as tochynge ye Q. magisties Shyppes*, 2 March 1579, B.M., Lansdowne MS 20.

[2] This essay lacks the professional knowledge displayed by Bourne, who gives details e.g. for the placing of a cable strengthened by chains across the Medway at Upnor Castle to 'stay' the Queen's enemies.

[3] Whether as a result of Bourne's representations or no, within three years of his death a heavy iron chain, raised and lowered by a windlass, had been placed across the Medway at Upnor. The cost was £600. See J. A. Williamson, *Hawkins of Plymouth* 1949), p. 264.

dedications of 1574 and 1580 alike, William Bourne terms the Lord Admiral his 'good lord and master', and one to whom he is indebted for favours, makes it reasonable to suggest that he was in some way attached to Lord Clinton's household, but there is no record of any definite appointment.

In the annals of Gravesend Bourne's death is recorded simply as that of 'a householder'.[1] Nevertheless, that he had achieved more than a local reputation is witnessed by an appreciative reference to him by a distinguished contemporary, Gabriel Harvey. This well-known critic and controversialist was a great admirer of the newly appearing 'mathematical practitioners', as appears from his marginal notes on some of their books. What he wrote in 1593 of William Bourne may therefore serve well as the inn-keeper's epitaph:

> He that remembereth Humphrey Cole a Mathematicall Mechanician, Matthew Baker a shipwright, John Shute an architect, Robert Norman a Navigatour, WILLIAM BOURNE a Gunner, John Hester a Chymist, or any like cunning, and subtile Empirique, (Cole, Baker, Shute, Norman, Bourne, Hester, will be remembered, when greater Clarkes shalbe forgotten) is a prowd man, if he contemne expert artisans, or any sensible industrious Practitioner, howsoever Unlectured in Schooles or Unlettered in Bookes.[2]

These self-educated men had, indeed, an advantage over those schooled in the classics in that they enjoyed a freshness of outlook and a readiness to speculate unchecked by an inculcated reverence for authority. Bourne, for example, had not been taught to look into the pages of Aristotle or Pliny for answers to questions on natural history. He could add to his *Treasure for Travellers* a fifth book in which he offers common-sense explanations of the origin of coastal land forms by erosion and deposition, of the saltness of the sea as derived from such veins of salt as are found in the rocks, of earthquakes, tides and currents and so on. Here a comparison may be made with

[1] See p. xx, n. 1. [2] Gabriel Harvey, *Pierces Supererogation* (1593).

another 'unlearned' contemporary, Bernard Palissy, the potter. Palissy drew large audiences in Paris to his lectures — based on observation — concerning the surface features of the Earth. It was no great disadvantage to William Bourne that he was, as he termed himself, a 'simple' man. He was also an intelligent one, a man who reflected on what he saw. And his books were read.

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I

An Almanacke and Prognostication for three yeares . . . nowe newlye added vnto my late Rulles of Nauigation[1]

EDITOR'S NOTE

During the reign of Henry VIII there was scarcely an Englishman to be found who was skilled in 'the New Navigation', new because it made use of mathematics and astronomy. Spanish pilots were employing it for their regular sailings to the New World, Portuguese pilots for reaching Brazil, India and the Far East, but in England it was still chiefly the military engineers who were interested in mathematical instruments, and in maps or plans. The English sailor found no use for the chart, nor for any instrument designed to measure the height of sun and star. He was satisfied to feel his way about the sea with lead and line, and to store his memory with land-marks and leading marks.

The reason for this contrast was simple. Our islands stand upon a broad platform, termed the Continental Shelf, over which the sea is less than a hundred fathoms deep. This shelf or platform stretches well out into the western ocean, and as it has a steep, almost cliff-like, outer edge the navigator approaching it from deep water, whether from the Atlantic or across the Bay of Biscay, is quickly aware that he has reached it. He is 'in soundings'. Although still far out of sight of land he early learned to judge his position merely by the minor changes of bottom contour and by the nature of the 'ground' brought up in the lump of tallow with which he armed his lead.

The Shelf, of course, has its special dangers. The range of the tides over it, that is to say the twice daily change of the depth of water, can be phenomenal at its inner limit. Moreover the tides generate powerful streams, cross-streams, 'rips', overfalls, and

[1] The title of the surviving edition of 1571.

even whirlpools as they ebb and flow. Such 'dangers' were all memorized by the sailor, and were written into his rutter or sailing directions. The 'good' pilot had first and foremost to know his tides, and this meant familiarity with the Lunar Kalendar, or 'Almanacke', in other words the changing phases of the moon. It is these that govern the monthly occurrence of spring tides and neaps, and their seasonal augmentations and diminutions. Fortunately the hour to hour positions of the moon during her monthly cycle had always been of first importance to the astronomer-astrologer, and by his rules the hour and date of each new moon could be predicted for centuries ahead. When printed Almanacs appeared in England at the beginning of the sixteenth century, they were obviously of special value to seamen, who could at once obtain from them the 'age of the moon' which governed the hour of each day's tides. Theoretically high tide should occur at any seaport when the moon crosses the local meridian, but in fact the arrival of high water may be delayed. The interval of time between the theoretical and the actual tide is termed 'the establishment of the port', which of course the local sailor learnt by observation from childhood. Like everyone else, he knew, besides, how to judge the time roughly by the position of the sun and stars, while as an apprentice to the sea he also had to learn to 'box the compass' (i.e. name its thirty-two points). He was further advised to practise with his pen the drawing of shore profiles and port entries, with their landmarks.

The simple navigating methods of the English sailor were also those of the sailors of Brittany and Normandy, and the first English sea-manual was taken from the French. Translated and edited by the printer, Robert Copland, it first appeared in 1528 under the title of *The Rutter*[1] *of the Sea*. It is, perhaps, a commentary on the backward state of English printing in that it does not contain the woodcuts of shore-profiles and harbour entries that were already to be found in its French counterpart.

[1] A word derived from the French *routier*.

By an accident of geography the method of navigation by lead and line sufficed also to carry the English West Country fishermen as far as the cod-banks of Newfoundland, where with their Norman and Breton neighbours they joined the Portuguese and Galicians. The Grand Banks are in fact just such an immense ocean-jutting platform as that on which the British Isles stand, and they have just such a steep edge towards the ocean basin. Long before he reached the American continent itself, the fisherman, dropping his 'dipsie' lead, found himself in soundings, and soon learned to move confidently about the Banks. These early American voyages (termed colloquially voyages to the Utter or Outer Parts) went practically unrecorded at home. They are only heard of when some dispute brought the participants into the High Court of Admiralty or when a Richard Hore took a few inquisitive gentleman passengers aboard as in 1536.[1]

The simplicity of the early navigation methods has its silent witness in the shape of the provision which the shipowner was expected to make for them. A study of ships' inventories shows almost invariably a mariners' or magnetic compass, a heavier (deep-sea) and a lighter (inshore) lead and line, with a dial or sandglass for measuring the two-hour half-watches. A pilot of the fifteenth or sixteenth century who wished to practise the 'new navigation' had himself to supply the instruments, tables and charts that were necessary for it. These were costly and so became his most precious possession. It was Francis Drake's habit, when he seized a ship, to throw the pilot's equipment overboard, leaving him bereft indeed.

The essence of the 'new navigation' is conveyed by the phrase 'running down the latitude'. The recovery of Ptolemy's maps at the beginning of the fifteenth century had reintroduced the method of defining geographical position in terms of co-

[1] The company mustered at Gravesend in April 1536. The lurid report of their adventures obtained many years later by the younger Hakluyt is not borne out by certain legal proceedings which followed the voyage. See E. G. R. Taylor, 'Master Hore's voyage of 1536', *Geogr. Journal*, LXXVII (1931), 469–70.

ordinates, that is to say, by the circles of latitude and the meridians of longitude on the globe. Once the latitude of a port is known, and its general position—either to the east or to the west of the observer—it can be found by the pilot of a ship despite the featureless, pathless waters around him. He seeks that latitude and follows it until the port is reached. The early Portuguese sailing manuals contained lengthening lists of key latitudes, and during the first years of the sixteenth century chart-makers added a meridian divided into degrees of latitude along the margin or down the centre of the chart. They still, however, drew the customary pattern of rhumb-lines (corresponding to compass directions) radiating from a formal arrangement of wind-roses, a pattern which had not been altered for centuries.

To navigate by the latitude, however, made much greater demands upon a pilot than navigating by lead and line. It involved an elementary knowledge of the sphere and its circles, the use of mathematical instruments and tables, besides the working out of a simple mathematical calculation. It involved, too, the appreciation of the properties of chart and scale, while the navigator had to know how to use a pair of dividers to take measurements and plot a course. The pilot, in fact, had to be a man of some education and must be carefully trained for his task, which explains why chief pilots in Portugal and Spain were men of standing, and might even be men of birth. In England it was an unusual thing for a gentleman to apprentice his son to the sea. The captain and chief officer of a ship, even the admiral of a fleet, were normally military men, and landsmen. The ship-master (who here was also the pilot) learned his craft by apprenticeship, and served under the captain's orders. Local pilots were taken aboard when a ship approached harbour, but in England there was no separate category of ocean pilots, although Bourne was to see in the course of twenty years the general acceptance of the 'new navigation' methods which he taught.

The exclusive rights of possession and exploitation in newly discovered territories which in 1493 the Pope had granted to Portugal and Spain were, as might be expected, early challenged by other sea-board countries, and particularly by France. French pirates and French 'illegal' traders (usually Huguenots) were soon frequenting the shores of West Africa, Brazil and the West Indies. To meet their needs a flourishing school of chart-makers sprang up at Dieppe and a number of outstanding French mariners mastered the new navigation. By 1535, despite the protests of the Emperor Charles V, exploration of the mainland behind the Grand Banks was planned and begun. The Master-pilot of this first adventure was Jacques Cartier of St Malo.

Within a very few years of Cartier's voyages, which centred on the St Lawrence River, two attempts were made to stir the English King Henry VIII to some similar action. A member of the English merchant-colony in Spain, Roger Barlow, presented the sovereign with a manuscript entitled *A Briefe Summe of Geographia* to which he prefaced a summary of the Spanish sea-manual.[1] This included all the most essential instructions for navigation by the latitude, particularly a four-year table of the sun's declination day by day. Towards the close of the text Barlow urged once again a proposal that his dead friend Robert Thorne had made long since, namely that the English should seek the Spiceries northwards by a trans-Polar route. Barlow wrote in 1541, and at about the same time one of the small band of highly skilled and already well-known French pilots, Jean Rotz, offered his services to the English King.[2] He too accompanied his offer with a manuscript of value to seamen. It included a set of working drawings for making an elaborate instrument by which the variation of the magnetic compass could be determined, and an actual instrument was presented with it.

[1] Edited by E. G. R. Taylor for the Hakluyt Society, 1932.

[2] E. G. R. Taylor, *Tudor Geography*, ch. IV. See also two papers on Rotz in *Journal of the Institute of Navigation*, VII (1954).

Henry VIII rewarded Rotz with a salaried post as Hydrographer (i.e. chart-maker), and the Frenchman (actually he was of Scots descent) prepared for him an elaborate atlas of charts in the style of the Dieppe school. To this he prefaced a sailing manual.[1] Yet, although there were subsequent rumours that a voyage was intended by the north, all this came to nothing.

Nevertheless, the Lord Admiral, Viscount Lisle (later Earl of Warwick and Duke of Northumberland), who took office in 1543, included overseas enterprise and conquest among his many ambitions. Among other foreign pilots he had taken yet another Dieppe mariner, Jean Ribault (later to become well-known) into his service. There had been, besides, for ten years or more, an English sea captain who had equipped himself for the new navigation. This was John a Borough, a Devonshire man, who sailed in the service of the Plantagenet Lord Lisle. He furnished himself with Spanish and Portuguese instruments, sea-books and charts, and could also himself draw a chart. His master was Deputy for Calais for several years before his death, and it seems likely that this continental outpost of England provided a useful intermediary for the transmission of Continental learning and techniques across the Channel.

When Edward VI came to the throne, Sebastian Cabot was sent for and was set to work with Jean Ribault to draw up plans and prepare charts for a voyage to Cathay. It seems odd that in spite of the fact that Sebastian, about forty years earlier, had sailed north-west and entered Hudson's Strait, the decision now was to go by the north-east. A young Bristol man, Richard Chancellor, was given some years' training at Sir Henry Sidney's expense to act as chief pilot after the Spanish style, and although John a Borough is no longer heard of, there now appears a Stephen a Borough (probably a son) who is competent to serve under Chancellor as Master. That he was familiar with the 'new' navigational methods his Journal for the 1556 voyage clearly shows. His younger brother William, also ap-

[1] B.M., Royal MS. 20. B. vii.

prenticed to the sea, was in the same ship, the *Edward Bonaventure*, although still before the mast in 1553.

Towards the end of Mary's reign, Stephen Borough (as he was now called) paid a visit to Spain, and was invited to witness the methods employed for training the Spanish pilots. He and his brother, now Chief Pilots of the Muscovy Company, had received advanced instruction from Dr Dee, but Dee never published his nautical manuscripts and tables,[1] and there was still a great shortage of skilled English mariners. Stephen thereupon persuaded a small group of the governing body of the Muscovy Company to provide the money for a translation of the leading Spanish sea-manual, a copy of which he had doubtless brought back with him. The book was Martin Cortes's *La Arte de Navegar* (1551) and the translator chosen was Richard Eden, historiographer of the early north-eastern and African voyages. Eden knew personally all the parties concerned, and had sat beside old Cabot on his death-bed. Himself a Cambridge man, his English version of the *Arte of Navigation*[2] was written in formal scholarly style, with a long and learned Introduction matching that of the original. And it is here that William Bourne comes into the picture.

Bourne studied the English *Arte of Navigation* very minutely, and came to the conclusion that whatever might be the case in Spain, where would-be pilots had to attend courses of instruction and submit to public examination at the Casa de Contratación, it was too difficult a book for the English apprentice to the sea. These youths needed something very plain and straightforward. They were likely to have a limited vocabulary and only a very elementary knowledge of arithmetic. Even the older men could not handle an astronomer's *Ephemerides* or

[1] In 1576 he put them together under the title of *Queen Elizabeth her Tables Gubernatick*, to form Volume II of *The British Complement of the Perfect Art of Navigation*, a four-volume work of which only Vol. I was ever printed. See Taylor, *Tudor Geography*, ch. VI; and Appendix A below.

[2] *The Arte of Nauigation . . . Written in the Spanysh tongue by Marten Curtes* (London, 1561).

work out the sun's declination from his place in the zodiac as Cortes apparently expected pilots to do. Bourne was speaking from experience. His own young stepson, James Beare, was a mariner's apprentice, as no doubt were others in his circle of acquaintance. He prepared a simpler version of the book for his pupils or 'friends', and then decided (or was persuaded) to publish this as an Addendum to his first *Almanacke and Prognostication.*

The printer who undertook publication was Thomas Purfoote, and he would necessarily need to obtain a 'license to print' from the Stationers' Company. But it seems that the printer of the English *Cortes* (who held what today would be called the copyright) was immediately up in arms, and Bourne had to cut his 'copy' where it appeared to duplicate Eden's translation. This translation had been printed by Richard Jugge, the Queen's printer. But what is known about the matter is only by inference from the remarks (with their undertones of petulance and protest) which Bourne interjected into his printed text. When, for example, he is explaining how to allow for the small angular distance which separates the Pole Star from the true Celestial Pole, he is obliged to substitute a new Rule, which he formulates in terms of the 'Pointers', two stars in the Great Bear. Yet, 'I would have pointed thee to Guard-Stars [he writes] but I could not be suffered.'

The Guard Stars, or Two Brothers in the Lesser Bear were those used for finding the height of the Pole by the Portuguese, Spaniards and French, and were essential adjuncts to the standard diagram that had appeared in all sea-manuals for eighty years or more. This diagram Bourne had perforce to omit. He was obliged also to say to the reader that if he wanted to know how much easting or westing he had made when sailing a certain distance on his course 'then read the *Arte of Navigation*'. And he must do the same to learn how to make and use his cross-staff or *balestilha*, 'for I must meddle with nothing contained in that book.' Finally and more specifically, when the English author came to the subject of navigating instruments in