ROBERT HOOKE (1635-1703): THE HIDDEN SURVEYOR REVEALED

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1. INTRODUCTION: A SUMMARY OF HIS LIFE AND WORK

Robert Hooke was born on 18th July 1635 at Freshwater in the Isle of Wight, the youngest of four children of the parish curate. He was a sickly child until he reached the age of seven and was not expected to live to adulthood. Without any private family income, he was taught at home by his father, but headaches and sickness frequently interrupted his studies. The only knowledge we have of his childhood from people who knew him comes from his friend John Aubrey (Powell, 1949) and Richard Waller (Waller, 1705). Aubrey tells us that the young Hooke had a talent for drawing, which Waller mentions too, but Waller also describes a remarkable ability to make mechanical toys and wooden clocks that would "go". In particular he describes a model ship with full rigging that Hooke made. It sailed across the harbour at Freshwater, with a contrivance for firing its guns as it went. It is not possible to say how far these descriptions of some characteristics of the young Hooke were influenced by what he later became.

Hooke's life changed abruptly when his father died in 1648. Aged thirteen, he left the little seaside town of Freshwater, crossed the Solent and went to London, taking his fortune of £50 which he had received in family legacies (Nakajima, 1994). He started life in London as an apprentice to Sir Peter Lely, the portrait painter, but after only a few weeks Hooke entered Westminster School. We do not know why he ceased his apprenticeship, or who helped him enter a school which, at more or less the same time, included Christopher Wren, Henry Purcell, John Dryden and John Locke amongst its pupils. Hooke had no scholarship, no private income and his legacies were only sufficient for a year's fees and lodgings, yet he remained at Westminster School for five years until he went to Oxford University in 1653. It is possible that Hooke's lively and gregarious nature and sharp intelligence so impressed Richard Waller, Westminster's Headmaster, that he enabled him to stay on and complete his studies there. If so, it was not the only time that the penniless Hooke received the patronage of powerful men, many of whom saw how useful he could be to them.

As a student at Oxford, Hooke had to earn money. He took work as a servitor to a Mr Goodman, despite having a choral scholarship at Christ Church. In 1655 he first came to the notice of a group of natural philosophers centred at Wadham College, including John Wilkins, Robert Boyle, Thomas Willis and others who later were to become formative members of the Royal Society. The aristocratic Robert Boyle was having difficulties making a vacuum pump for his experiments with air. Hooke soon made his opinion known that the materials Boyles assistant were using were not good enough, so Boyle sent Hooke to London to seek some that were better and then employed him to make his pump. Hooke continued working for Boyle in Oxford and

London until, in 1662, he was, with Boyle's permission, appointed Curator of Experiments to the Royal Society, for whom he worked with zeal, although he was paid little and frequently more than a year late.

As one of the Society's employees, Hooke was ordered by the clerics, aristocrats, courtiers and physicians to undertake sometimes as many as six demonstrations and experiments at each of their weekly meetings. These were usually haphazard, ranging from weighing partially evacuated glass bubbles, listening to the different noises made when they were broken and then weighing the debris, to curing sick dogs by skin transplants and blood transfusions. He desperately tried to prepare and test his methods and instruments beforehand, often failing through lack of time and suitable materials. Amidst the welter of capricious investigations put upon him by the Fellows he succeeded in making a microscope and publishing in *Micrographia* (Hooke, 1665) detailed drawings and written descriptions of what it revealed to him. Many of the details of animal, vegetable and mineral objects he showed had never been seen before; for example he was the first to show and name the cellular structure of plants. The beautifully produced book was a remarkable achievement, not only for the powerful images created through Hooke's painstaking and skilful draughtsmanship, but also for his verbal descriptions and suggestions about why things were as they were observed to be. The publication of *Micrographia* was seminal in the use of drawings as an integral component of scientific rhetoric. *Micrographia* astonished most of literate London and soon went into a second edition. It was the first popular book on science and should have secured his reputation as a major figure in the early development of systematic empirical methods of investigation. But that was not to be.

In 1665 Hooke was appointed Professor of Gresham College. Sir Thomas Gresham, a sixteenth century merchant and banker to Queen Elizabeth I established by his will a college in his name in London to provide salaries for seven of divinity, law, rhetoric, physic (medicine), astronomy, music and geometry to give lectures in Latin and English for the citizens of London. The college was established in 1597 at Gresham's former house in Bishopsgate Street where the Royal Society was allowed to hold its meetings. Gresham College was administered by the City of London and the Worshipful Company of Mercers - men quite different from the Fellows of the Royal Society. Hooke, now aged 30, for the first time in his adult life had accommodation and a regular salary (£50 per annum) for a lifetime. His position seemed to become even more secure when Sir John Cutler offered to pay him an annual salary of £50 to give lectures at the Royal Society meetings on the history of trades. However, the Royal Society quickly decided to reduce by £50 the salary of £80 it had agreed to pay Hooke (but often paid late) and despite giving his Cutlerian Lectures, Hooke was not paid by Cutler until he took a successful court action for payment 30 years later.

Hooke spent nearly all his working life in and around Gresham College. He is well known for his scientific investigations, but to date only one biography has been published ('Espinasse, 1957). He continued to give his Cutlerian and Gresham lectures and undertake experiments for the Royal Society. It was through his seemingly inexhaustible energy and inquiring mind that the Royal Society meetings did not become more entertainment for gentlemen than investigations into natural philosophy. Hooke's determination to design and make instruments for measuring natural phenomena derived from the Baconian viewpoint that observation, rather than accepted authority, leads to understanding and knowledge of the natural world and consequently to power over it. In *Micrographia* Hooke wrote that it was necessary to compensate for the defects in mankind's senses by making instruments for observation and measurement. In his lifetime he designed and made optical and mechanical contrivances for many purposes. He sometimes failed to achieve the accuracies that he knew were possible because of the limitations of methods for making the optical and mechanical components and the intractability of the materials then available. These failures frustrated many of his ambitions and probably were one reason for his long-lasting and often ill-tempered disputes with Newton (about gravity and light) Hevelius (about telescopes for astronomical measurements) and Huygens (about timekeepers).

His dispute with Newton in particular had a severe effect on Hooke's reputation that lasted for more than 200 years after his death. Newton delayed accepting the Presidency of the Royal Society until Hooke had died. By then, Newton's reputation was unassailable and men sought his favour by denigrating all that Hooke had done. The concluding years of Hooke's life in Gresham College passed with increasing infirmity and, ultimately in squalor. His estate, most of it in cash in a trunk under his bed, was valued at about £10,000 (Hunter & Schaffer eds., 1989) which at the time was of the same order as the estate of a merchant banker. This was an astonishingly large sum for an employee of the Royal Society receiving infrequent and late partial payments of his annual £30 salary to have accumulated. As will be shown, nearly all of Hooke's fortune came from his work as surveyor. As a Gresham Professor, Hooke had to remain celibate. He died intestate, but in the later years of his life he had intended to use his fortune to endow the Royal Society with its own premises. It seems as if internal wranglings amongst members and the increasing animosity towards him shown by supporters of Newton prevented Hooke from formalising these intentions.

2. THE GREAT FIRE OF LONDON

In five days and nights in September 1666 most of London was devastated by fire. It began in the early hours of Sunday morning 2nd September 1666 in a bakehouse in Pudding Lane, just north of London Bridge. A strong wind from the east soon fanned the flames. The fire spread rapidly westwards from roof to roof above lanes and streets lined with overhanging houses, most with timber frames and lath and plaster walls. In the shops and workshops and in streets and enclosed courtyards close to the River Thames and its warehouses lay inflammable materials used by the citizens for their daily business. Straw and chaff for horses, tallow for candles, stores of tar, pitch, hemp and flax, kindling and coal for fires and furnaces, all added to the growing conflagration. At first the fire seemed no different from others that had occurred, but this time the weeks of hot, dry weather preceding the outbreak and the exceptionally strong wind soon made containment by the usual method of pulling down houses ahead of the advancing fire ineffective. The labour and time required to demolish the houses were inadequate for finishing the task before the fire was upon them. Fire-fighting with water pumps was almost impossible. The fire engines could not negotiate the narrow and crooked streets and lanes, many of which were cluttered with market stalls and detritus of all kinds, to reach the advancing fire front. By the end of Sunday it was clear that this was no ordinary London fire. Citizens fled westwards and across the river, taking as many belongings as they could manage. The Lord Mayor, Sir Thomas Bludworth, thought of using gunpowder to blow up houses to provide fire-breaks, but he knew that the City (here "City" is used to describe the men and organizations who governed London; “city” is used to describe the geographical London) could not afford the expense of destroying citizen’s houses and he feared explosions would give rise to civil insurrection.

The King sent troops under the command of his brother the Duke of York into the city to quell minor disturbances and so prevent a major riot. In the confusion rumours of arson, or invasion by the French or Dutch, or a popish plot (following the failure of the “Gunpowder Plot” a quarter of a century earlier) fuelled anxiety and retaliation by the citizens. However, complete breakdown of law and order was avoided. By close cooperation between the King’s militia and the City’s aldermen and deputies working within their wards and parishes with their constables, local problems were discovered and dealt with before they could become more widespread. Although much petty crime took place, the overall social stability was maintained.

The fire continued burning day and night until, by sunrise on Thursday 6th September, the flames had died. The city smouldered, ready to burst into flames again, but the wind had dropped and the destruction was over. About 85% of the area of the city had been destroyed (Porter, 1996). More than 70,000 citizens were homeless, many living in villages and open spaces outside the city with what few possessions they could salvage. More than 80 churches, including St Pauls, were destroyed, with 44 of the 51 livery halls (the centres for the city’s crafts and trades) and important buildings such as Guildhall, the Customs House, the Royal Exchange, prisons, law courts and gateways (Bell, 1923). The social, commercial, legal and administrative fabrics of London life were ruined. ruins. Only a small area in the north-east corner remained unburnt. Amongst the stone buildings still standing in that part was Gresham College which the City soon took over for its business, the Guildhall having been burnt-out. Hooke however remained in his rooms, but many occupied by other Gresham Professors were requisitioned by the City. Already Hooke was known to the rulers of the City because they had appointed him Gresham Professor only a year earlier. He was living amidst the group of administrators and officials who were facing the daunting task of re-establishing normal civic life and business without delay. Hooke lost no time in presenting himself as someone who could be useful in that task. He was soon to play a major part in the rebuilding of London which has, until recently (Cooper, 1996, 1997, 1998a, 1998b) been largely neglected by scholars.

3. HOOKE, CITY SURVEYOR AND RE-BUILDER OF LONDON

Only two weeks after the end of the fire, Hooke presented to the City his plan for rebuilding London. It so impressed the Lord Mayor and Aldermen that they preferred it to the plan drawn up by the City’s Surveyor Peter Mills. They asked the Royal Society for permission to present Hooke’s plan to the King. The Royal Society President, Lord Brounker, eager to foster good relations with the City who had made Gresham College available to the Society, and with the King, the Society’s patron, readily agreed. At least five other plans for rebuilding were made, including one by Christopher Wren who presented his directly to the King. None of the plans was carried out because the City could not afford the time or the cost of acquiring land and rebuilding the city on new foundations. Normal trade, commerce and business had to resume as quickly as possible so that both the citizens and the City could begin to receive income so it was decided that rebuilding should take place largely on the old foundations (Reddaway, 1940).

The City, having appointed Hooke as Gresham Professor of Geometry and having preferred his plan for rebuilding to that of their own Surveyor, now sought from him a vital contribution as one the City Surveyors responsible for rebuilding. Before the Great Fire, the City Surveyor was selected from the City's master craftsmen and was mainly concerned with overseeing the costs and workmanship of the City's own building works. After the Great Fire, three Surveyors were appointed: Peter Mills, master bricklayer and Surveyor before the Great Fire, Hooke and John Oliver, master glazier and citizen. Hooke's appointment was very unusual. He had no background in the building crafts and was not engaged in City life. The City rulers however had known about Hooke for some years and no doubt recognized that he was the intellectual equal and scientific colleague of Wren, one of the King's Commissioners for Building. Maintenance of good relations between the King and the City during the difficult time ahead when legal and technical issues had to be quickly settled and acted upon was more likely if Wren and Hooke were in partnership in the enterprise. Hooke, since his Oxford days, had demonstrated exceptional knowledge and practical skills in the crafts of instrument making so he could understand how building craftsmen worked and what they could achieve. The City would have noticed too Hooke's lack of a private income and the irregularity of salary payments to him by the Royal Society and have realised how important the City Surveyor's £150 annual salary, paid regularly every quarter would be to him. In appointing him, the City was not taking a risk, but identifying an unusually knowledgeable and competent man who had the right connections and who would serve their present needs with energy and efficiency in return for greater financial independence of the Royal Society.

The City's opinion of Hooke was fully justified. He supervised the team of surveyors who made a plan of the ruined streets. He was present when the King marked on it which streets he wanted to be widened, or new-built, where new markets were to be located and new quays built alongside the Thames and Fleet rivers. He worked with Wren in drafting the new building regulations which were to transform London from a jumble of decaying wood and plaster buildings to a safer and more orderly city of stone and brick, but the pattern of mediaeval streets was not much changed.

On 27th March 1667 Hooke and Mills (Oliver was not appointed until January 1668) began staking out the new and widened streets. Nine weeks later that task had all but finished and the two City Surveyors began to stake out and certify the foundations for private building. The procedure was for an owner to pay to the City 6s-8d (approx. 33p) for each old foundation to be rebuilt on. The owner would then show the receipt to one of the City Surveyors and arrange a time to meet at the site and negotiate a fee to be paid to the Surveyor for issuing the certificate. The owner was responsible for clearing all rubbish from the site to reveal the old foundations. At the due time the Surveyor would arrive, identify the old foundations, mark them with stakes (taking account of any road widening), measure the dimensions of the site and issue a certificate to the owner in exchange for his fee. Only when the owner was in possession of the Surveyor's certificate could he start to rebuild. When an owner had land taken away for new or widened streets, or a new market or quay, the Surveyor measured and certified the area of land taken away. The owner then took the certificate to the City for payment of compensation, normally 5s-0d per square foot (approx. £2.69 per square metre). Records at the Corporation of London

Records Office (CLRO) show that in the eight years 1667-74 about 8,000 foundations had been surveyed and certified, nearly 3,000 of them by Hooke, the remainder by Mills (who died in 1670 and was not replaced as City Surveyor) and Oliver.

Another of Hooke's major duties as Surveyor was to visit building sites to settle disputes between neighbours during rebuilding. In response to a citizen's complaint to the City, at least two of the Surveyors, sometimes accompanied by Aldermen or Deputies of the Ward where the dispute arose, went to look at the evidence (or make a "view") question the contending parties and recommend to the City how the dispute should be settled. Many views were related to intermixture of interests where new party walls, which had to be built vertically from the ground, replaced overlapping, overhanging and intermixed storeys in the old buildings. CLRO evidence of the number of views undertaken by Hooke in the years 1668-1674 has important gaps, but it may reasonably be deduced that more than 500 were completed by him in that time. Disputes were usually complicated and of great importance to the parties involved in the dispute. It is astonishing to see so much evidence of the way Hooke regularly understood the main issues, acted quickly and with a sense of fairness in his decisions. Although legally the decision was made by the City, Hooke's recommendations were almost always accepted by the City and, in turn, by the parties in dispute. It is remarkable how Hooke, so disputatious in his science, took such great care to remove it from civic life and to do so very effectively. It might be that in both cases his concern was with equity - which he dispensed as Surveyor, but felt he did not receive as Scientist.

Hooke's duties as Surveyor extended to detailed supervision over many years of the City's building works. By countless visits to building sites and careful scrutiny of the work and documents he ensured the workmanship was properly carried out and charged for at reasonable rates, the bills of quantities accurately estimated and costs of materials acceptable. With Wren he designed and supervised the building of retaining walls for the Fleet River which had to be repeatedly re-built and re-designed as the lateral pressure on them from groundwater on either side of the valley caused collapse. He spent a great deal of effort in trying to clear the north bank of the Thames to build a wide quay and new wall, but ultimately the project failed because neither the King nor the City could afford the cost of compensating owners of the wharves alongside the river for loss of their property and livelihoods. Hooke designed and built the Monument. He designed or supervised the building of new gateways in the city walls. In the area of public health he supervised mapping for, and setting out of, new sewers and conduits and decided on sites for latrines and laystalls (places where citizens could lay their rubbish for collection) and worked closely and regularly with Wren on the city churches, including St Pauls.

Hooke received not only his salaries from the City for his appointments at Gresham College and as City Surveyor amounting to £200 per annum, but received fees from citizens for his certificates and reports on views, for his work on rebuilding the London churches and for privately commissioned architectural work (Bedlam Hospital, College of Physicians, London churches and Ralph Montague's house amongst others) brought Hooke's annual income at this time to around £500, placing him amongst the wealthier middle classes. Only £30 of his income came from the Royal Society.

Hooke's surveying has been largely neglected by scholars. The standard account of the rebuilding of London (Reddaway, 1940) makes little mention of Hooke and historians of science have either ignored his surveying or misunderstood it. Despite his exceptional gifts in devising instruments for measurement he made no advances in instrumentation for surveying in his role of City Surveyor because none was necessary. Linear measurements with rod or line were fit for purpose. And yet for about eight years surveying in the widest sense as it is understood today took much of his time and brought him considerable financial reward. It has been estimated (Cooper, 1999) that he spent most mornings in the aftermath of the Great Fire on his City business, going about the rubble-strewn streets, standing amidst the ruins of houses, shops and workshops talking to citizens, observing, measuring, listening, reading documentary evidence and recording details in his survey books, which are now lost. The Hooke who worked in the streets of London showed personal characteristics quite different from those usually attributed to him by historians.

In just eight years after the destruction of London, rebuilding was for all practical purposes completed. The fears of insurrection in the days of the Great Fire and the following few months were allayed as citizens saw the slow return of normal life begin to quicken. The Fire Courts dealt with matters of title and with disputes between landlord and tenant (Jones (ed.) 1966). The City dealt with legal and technical matters relating to rebuilding. In each case hard work by a few men dedicated to serve the public interest enabled the citizens to re-establish their life and businesses without undue delay or exploitation. Hooke was one of those men.

4. HOOKE'S SCIENTIFIC SURVEYING

Amongst the many mechanical and optical devices Hooke conceived for scientific measurements and investigations were some that later came to be incorporated in surveying instruments throughout the centuries following his death. A few of these are now described.

4.1 Hydrography

Hooke visited many times various coffee houses in London where he met, smoked, ate, drank coffee, gossiped and debated freely with a wide cross-section of society. In Garraway's for example, the clientele was mainly engaged in maritime trade as merchants, underwriters or ships' captains. Hooke frequently gave to the seafarers lists of observations and experiments he wished them to make in far-off lands and objects to bring back for scientific study. In September 1663 he presented to the Royal Society his first mechanical devices for collecting samples of sea-water from any depth and for depth-sounding without using a line (Gunther, 1930). The samples were collected by lowering a container C (Figure 1, left) attached to a bracket B by a line attached at F. The vanes E (with arms D hinged at the bracket B) opened as shown when the device was lowered through the water. When the pre-determined depth had been reached according to the knots on the line, the line was jerked upwards, closing the vanes E on their arms D so that the container C became sealed as at G. The container with the sampled water inside could then be raised to the surface, the vanes E remaining closed. The depth-sounding device (Figure 1, right) was made of a weight D having a fixed ring E, connected to a buoyant ball A having a long staple B, by a spring clip C. The contraption is released from the water surface and falls to the sea bottom whereupon the inertia of the ball A depresses the spring C which frees the ball A to return to the surface. The "time of flight" is recorded and can be converted to depth if the speed of the falling weight D is equal to the speed of the rising ball A and is known by calibration. It is likely that Hooke had the simple devices made and then tested by mariners, because from time to time he reported on various significant and increasingly ingenious improvements, the last in December 1691 (Hooke, ed. Derham, 1726).

4.2 Stereoscopic mapping

Figure 2 illustrates the first of a series of thoughts Hooke had in 1694 which came very close to being a description of accurate stereoscopic mapping about 200 years before stereo-photogrammetry became feasible. The first thought was about how inaccurate and incomplete sketches often made by mariners of newly discovered shorelines could be improved so that others visiting the places later could navigate more safely. In 1666, only a few months before his life was changed by the Great Fire, Hooke had described to the Royal Society some uses of a "picture box". By 1670 he had made and used a camera obscura which presented an upright and unreversed image to the user (Cooper, 1996). Then, in 1694 it came to his mind again when he was thinking of mapping coastlines by simultaneous horizontal and vertical angular measurements from the ends of a measured baseline aboard ship. He proposed two double motion two-foot (about 0.6m) sextants with telescopic sights mounted on pedestals using what would now be called constrained centring for measuring the angles to features on shore. He said the accuracy of measurement of the separation of the centres of the pedestals was paramount and that they should be at the vessel's stern and bowsprit head, or otherwise as far apart as possible. He said that the observers should agree beforehand on an observing programme and that when observing they could communicate with one another by pre-arranged signals on a line between them. The juxtaposition in his mind of perspective projection for accurate recording of directions and simultaneous intersection of observed directions for locating the positions of features is the concept of analytical photogrammetry, but without photographs.

4.3 Opto-mechanical instruments

Hooke's ability to conceive new opto-mechanical instruments of high accuracy was far in advance of the technology necessary to make them successfully. Except for his microscope, which revealed for the first time the astonishingly complex details of small objects, and his observational telescopes which revealed similar complexity in the very large, his attempts to combine optical and mechanical technologies in practice were generally unsuccessful. More than a century of slow progress in the understanding of properties of opto-mechanical materials and of manufacturing techniques was necessary before some of his designs could be made with sufficient accuracy and stability for regular usage as scientific measuring instruments.

In one of his published Cutlerian Lectures (Hooke, 1674) he argued that telescopic sights were necessary to improve the accuracy of observations for positional astronomy beyond what was obtainable with open sights, even when used by the most experienced and acute observer. He criticised the Danish astronomer Hevelius for using open sights for observations intended to improve on Tycho Brahe's astronomical tables, saying that telescopic sights would give measurements 40 times more accurate. Hooke made a claim, scorned by Flamsteed, the Astronomer Royal, that it was possible to make an instrument that could be held in the hand and which could measure angles to 1 second of arc; such instruments were eventually made more than 250 years later by Heinrich Wild. A design of an equatorial quadrant (Figure 3, from Hooke,1674) has many mechanical and optical components that were commonly used in surveying and photogrammetric instruments until only a decade or so ago such as a tangent screw, micrometer scale, double catoptric telescopes for coincidence imaging, universal joints, hand-wheels and gear-trains. Hooke gave detailed drawings and dimensions of the components with instructions for making and assembling them. A clock mechanism controlled by a conical pendulum rotated the polar axis so that a star appeared stationary to the observer. There is no evidence that an instrument was made. It is highly unlikely that it would have performed satisfactorily for long; the machinery, workmanship and materials were at that time quite inadequate.

4.2 Gravimetry.

The measurement of the earth's gravitational force and its variation with distance from the earth's surface was the theme of a series of experimental investigations with pendulums, balances and falling weights that Hooke performed in the years before the Great Fire and which he continued from time to time later. Through these experiments Hooke tried, but failed to discover what he thought must be true: that the earth's gravitational force followed an inverse square law. He lacked Newton's mathematical genius and capacity for abstraction that later would result in *Principia*, but as a mechanist he sought evidence by experimentation. On the roof of Westminster Abbey he used a balance to weigh a piece of lead with a thread attached. Then he attached the other end of the thread to the balance pan and lowered the lead to just above the surface immediately below and re-weighed it to see if it weighed more, or less, when closer to the surface of the earth. After several trials and independent checks he concluded that if there was a variation in gravitational attraction over the height difference used, it was too small to be measured. He continued similar experiments over greater height differences, making use of the steeple of (old) St Pauls and some mines at Banstead Downs in Surrey, but with the same conclusions. He experimented with pendulum clocks at the bases and summits of hills, and with timing falling bodies at different elevations, but could detect no changes. He recognised that it was necessary to design a mechanism that would change noticeably as a result of a very small change in gravity. He produced a sketch (Hooke, 1666) showing a weight counterpoised by a spring in such a way that a small change in gravity would produce a noticeable flexure in the spring, so introducing a principle of gravimetry which only much later could be made to work.

5. CONCLUSIONS - HOOKE REVEALED

This paper has dealt mainly with Hooke's work as City Surveyor. It shows him to have been extraordinarily well organised, fair-minded, efficient and astonishingly energetic. Although his phenomenal energy has been noted by writers on his science, they have generally described him as devious, irascible and of dubious morality. Yet in his engagement amidst the ruins of London with the daily clamour and disputes of London's citizens, desperate to rebuild their lives and their businesses after the Great Fire, he showed high civic virtue. He practising surveying in most of the areas covered today by the Commissions of FIG. In instrumentation he was far-sighted in defining the principles of, and making detailed designs for, optical and mechanical components that were used in surveying instruments for the following 250 years. Interest in Hooke's science and philosophy was reawakened at the tercentenary of his birth. As we get closer to the tercentenary of his death he is seen as an important but difficult and idiosyncratic figure in renaissance science. This paper shows that he can be seen not only as the first professional scientist, but as the first professional surveyor, practising in areas ranging from geodesy to property valuation and management. The rebuilding of London after the Great Fire was accomplished speedily and without civil unrest or dissatisfaction. In that achievement, Hooke's contribution through daily actions on behalf of the citizens and the City was greater than that of any other individual.

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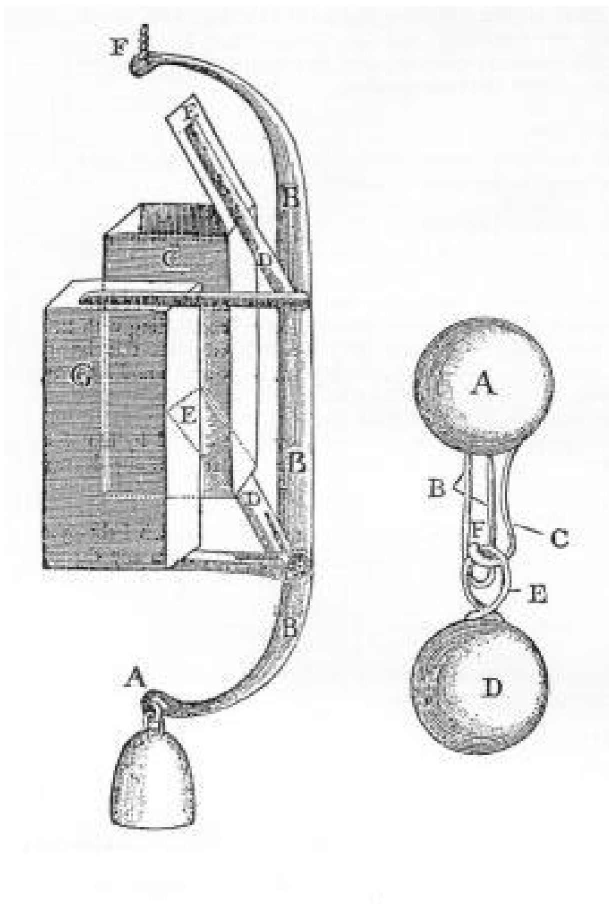

Figure 1
Hydrography
Left: device for collecting water samples from different depths
Right: device for sounding depths without a line

Figure 2
Towards photogrammetry

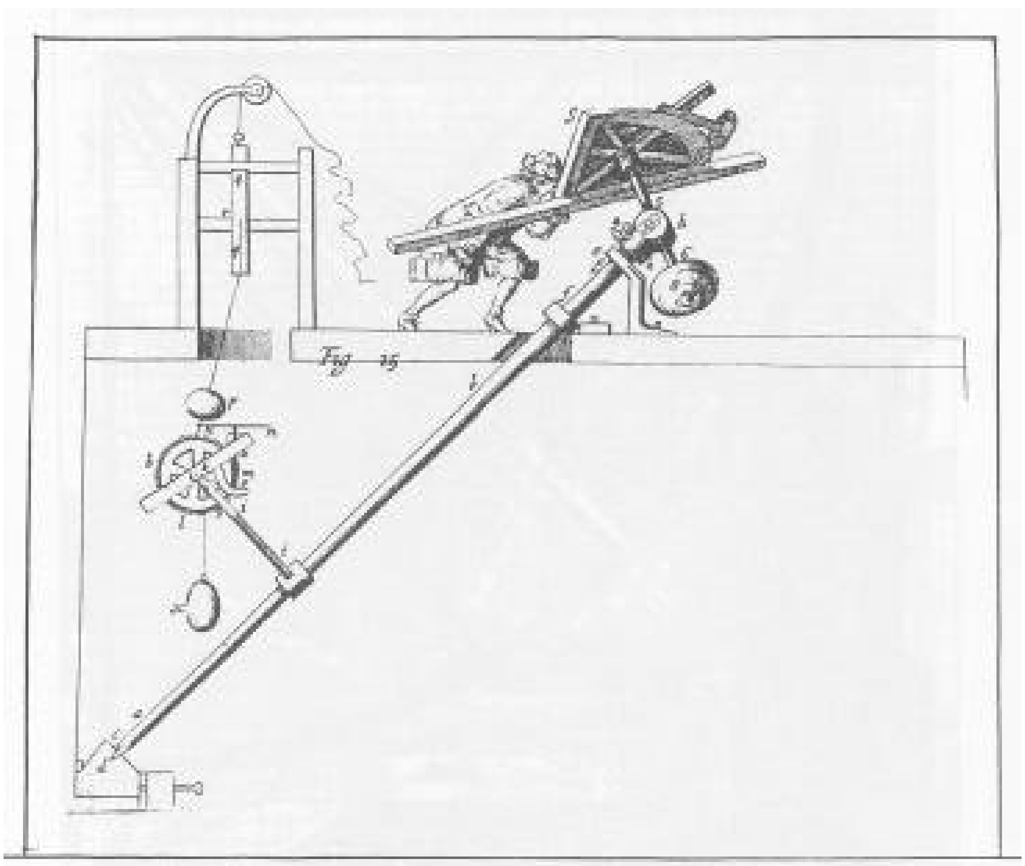

Figure 3
Hooke's equatorial quadrant