

Jeremiah's Theodolite

Edwin Danson

In November 1768, Charles Mason and Jeremiah Dixon returned to London from the troubled American colonies. For five gruelling years they had been surveying amongst the fields, forests and mountains of the New World to settle a long-standing, often violent, boundary dispute. Their monumental survey, best known today as the Mason-Dixon Line, survives as testimony to the scientific excellence, fortitude and undaunted courage of two of Britain's great unsung heroes.

One hundred forty years later, in November 1915, the descendants of Jeremiah Dixon bequeathed to the Royal Geographical Society an eighteenth century circumferential instrument. Known as "Jeremiah's theodolite", there is a tradition in the family that the instrument was used on the great American survey.

A chance reference in an old newspaper stimulated the quest to rediscover this forgotten piece of Anglo-American history.

Background to a famous partnership

Charles Mason ARS, was born in Oakridge, Gloucestershire, in 1728. Educated at Tetbury grammar school and by Robert Stratford, a local mathematician, Mason's exceptional mathematical abilities came to the attention of Dr James Bradley, the Astronomer Royal, who offered the twenty-eight year old the job of live-in assistant (or Labourer, as they were known) at the Greenwich Observatory.

Five years after his appointment arose the prospect of observing a transit of the planet Venus across the face of the Sun. This observation, the first opportunity for more than a century, would allow astronomers to calculate the distance of the Sun from Earth and provide a scale to the size of the Solar System. As the date for the transit approached, the Royal Society of London chose Mason and the Cambridge astronomer, Reverend Nevil

Maskelyne, to observe the transit from St Helena in the South Atlantic. At the last minute, the Society decided to despatch observers to the East Indies; instead of assisting Maskelyne, Mason was to go to the East India Company's trading post at Bencoolen, Sumatra. Mason needed an assistant and John Bird, the famous London instrument maker and Fellow of the Royal Society, recommended Jeremiah Dixon, the son of an old friend.

Born in 1733, Jeremiah Dixon was a land surveyor and amateur astronomer from Cockfield in County Durham. The Dixon family were proprietors of a coalmine and traded in various coal products. Although artisans the Dixon's, who were Quakers, could not be described as poor; Jeremiah owned surveying instruments and an astronomical telescope. He was just 27 when the letter arrived inviting him to assist with the transit of Venus observations. Eager for the chance, he readily accepted the Society's invitation to accompany Mason to Sumatra; but first, he had to pass a stiff interview at the Royal Military Academy in Woolwich. The examiners were anxious to establish at which university Dixon had studied astronomy. Cambridge or Oxford? 'In a pit cabin on Cockfield Fell,' replied Dixon. Despite the bluntness, his credentials were sufficient and Bird's recommendation alone was enough for the commissioners. He got the job and thus, in the autumn of 1760, began the famous Mason & Dixon partnership.

As it turned out, their trip to the orient became quite an adventure; the partnership nearly came to an untimely end when their ship was attacked by a French man o' war. Instead of Sumatra, the pair ended up in Cape Town, but that is another story. Their observations in South Africa were a total success and they returned to London victorious. Also in London at the time were Thomas Penn, the elderly joint proprietor of Pennsylvania, and Cecilius Calvert, the uncle of the young Lord Baltimore, proprietor of Maryland. With the assistance of the Astronomer Royal, these two aristocrats were scouring London seeking assistance for the surveying of their contentious borders to meet the terms of a recent court judgement and end their eighty-year-old quarrel. Calvert and Penn immediately recognised that in Mason and Dixon was the perfect team to solve the American border dispute. The rest is history.

As far as is known, Mason and Dixon used only three optical instruments in America to survey and set out the complex boundaries that divided Maryland from Pennsylvania (the Mason-Dixon Line) and from the Three Lower Counties (Delaware). These instruments were all made for Penn by John Bird at his workshops in Court Gardens, off London's Fleet Street and comprised:

- A six-foot radius Zenith Sector for measuring zenith distances of stars for determining latitude
- A thirty-three inch transit and equal altitude instrument, the great grandfather of the modern theodolite; and
- An 18 inch radius Hadley pattern quadrant

The fact that the telescope of Bird's transit and equal altitude instrument could be 'turned end for end' (i.e. transited) once led to a belief that Mason and Dixon also used another instrument called a circumferentor or compass transit. These instruments were in common use for general surveying and mapmaking but were not employed for the 'geodetic' survey because they were neither accurate enough nor necessary. This is not to say that they did not take a compass with them – no surveyor in their right mind, then or now, would dream of venturing into the unexplored wilds without a compass. Indeed, a surveyor's compass was necessary for setting out short offsets (which they did regularly) and for tracking the courses of the rivers and the roads that crossed the Line. A surveying compass, made in 1765 by the American Joel Baily, Mason and Dixon's right-hand man, may well have been made especially for this purpose (Bedini).

Jeremiah's theodolite

The January 1916 edition of the Geographical Journal, referring to the 'theodolite', contains an article recording that 'By the generosity of Mr. Edward Dixon of Hull the Society's collection of instruments has been enriched ...'. Described as a theodolite, the instrument is in fact a circumferential or surveying compass. When Jeremiah died in 1779, he left mysteriously much of his considerable estate to a lady and her daughter. His 'theodolite', though, went to his nephew, John Dixon, and was passed down to John's grandson Edward.

On 1st August 1915, Edward generously signed the documents transferring to the Royal Geographical Society this example of a fine 18th century instrument. Its history while in the Society's care, as far as is known, is not documented but it can be assumed that it was cherished. As the closing paragraph of the Journal's tribute puts it: 'Such gifts help to realize the ambition expressed by Sir Clements Markham ... that the Society might possess a collection of instruments for navigation and survey representative of all periods'. Sixty years later, the Royal Geographical Society negotiated its permanent loan to the Science Museum so that this historic instrument could find a wider audience.

The 'theodolite' was made in the workshops of George Adams of Fleet Street and consists of a 12" diameter brass ring hand divided in degrees and engraved with the makers name; *Geo Adams LONDON*.

A single vernier scale at the base of one of the brass sights is divided in 5-minute intervals, permitting readings to about ½ minute of arc. The observing sights are doubled – on the vernier side the observer looks through the top slit and through the bottom on the opposite sight. A brass cruciform joins the circle with the central spigot around which smoothly rotates the sighting alidade.

The centre of the instrument is a fine, steel-engraved, compass housed in a brass case 6" in diameter. The outer rim of the compass is stepped and shows a full circle divided into degrees, starting with 0° at north. Below this, on the circumference of the compass plain, is a circle divided into the four cardinal points which themselves are subdivided into degrees starting with 0° at North and South and increasing to 90° at East and West. The central part of the compass is divided elegantly into the primary eight compass points.

The compass needle is a symmetrical design dry-mounted on a jewelled pivot with another jewel above to bear on the glass cover when the needle is released from its clamp.

Two spirit levels are mounted on the face of the compass to facilitate setting the instrument in the horizontal. These levels, each containing vials 1³/₁₆" long, have screws at either end for calibration adjustments. Beneath the instrument is the mounting point, a simple smooth bore of brass for mounting onto a ball and socket or similar device.

History

The date when Jeremiah Dixon acquired the instrument is not known. However, although conjectural, it is reasonable to suppose he bought it ‘off the shelf’ from the Adam’s workshop sometime between March 1762 and September 1763. According to the *Geographical Journal* of 1916, in a 2nd edition of a work by George Adams the younger contains is a description ‘of the “Common Theodolite” – as distinct from the “Theodolite with Telescopic Sight” – which agrees in general with our instrument – though ours has only two sights, in place of the four of the ‘common theodolite’ and in this respect is more like the Circumferentor...’.

Most probably, Dixon purchased the instrument with the advance he and Mason received when the deal with the colonial proprietors was agreed, about August 1763. Dixon, a land surveyor by trade, would doubtless have felt uncomfortable about going to America without the surveyors’ principle tool, the Total Station of its day. His friend, John Bird, was renown for his astronomical instruments and probably it was he who recommended the Adams’ for a stock item like a circumferentor.

Almost certainly then, the ‘theodolite’ went to America and was used for reconnaissance, setting out offsets and for observing the features that crossed the Line. The fact that Joel Baily also built a compass for the duo confirms the value of these instruments for the survey. Maybe Baily used Adams’ instrument as a model for his own.

Assuming this conjecture is correct, then the Science Museum’s instrument has seen some very interesting times and has passed through some exciting escapades as Mason and Dixon pushed westwards through the dangerous backwoods of colonial America.

Usage

The circumferential was the eighteenth century instrument used for ‘chain and compass’ surveys, much employed during the English land enclosures of the time. Dixon’s instrument is an ‘upmarket’ model compared with many examples then in common use. It was also the instrument favoured in America and employed for similar property surveys. An interesting document that illustrates the results of such surveys is the plan produced

by in 1796 of the Harlan plantation that Mason and Dixon made their headquarters between 1764 and 1768.

A similar sort of instrument was also employed by the colonial commissioners' survey team when, between 1761 and 1763 they attempted the almost impossible task of setting out the tangential line that forms Delaware's western border. It was their lack of success in running this eighty-mile long line that spurred the provincial governors to appeal to their proprietors to seek professional assistance and which, in turn, led to Mason and Dixon's appointment.

Conclusion

Six months after returning to England from America, Dixon was teamed with Greenwich 'labourer' William Bayly, to observe for the Royal Society the second transit of Venus from North Cape, Norway. As a side job, they were instructed to map the northern archipelago and establish longitude. No doubt the 'theodolite' went as well and would have been indispensable for much of the mapping.

'Jeremiah's theodolite' (Inv 1977-755) is now on display in the Science Museum, London, and resides in good company. Behind the instrument stands John Shelton's magnificent astronomical regular (Inv 1914-591) that Dixon took to Norway to time the transit and which later accompanied William Wales and William Bayly on James Cook's round-the-world epic. Alongside stands John Bird's quadrant (Inv 1900-138) that Dixon also used in Norway and which was later used by Maskelyne during his famous gravity experiment on Schiehallien, in Scotland.

When Dixon retired 'a gentleman', he continued to employ his surveying skills. He was a respected scientist and was elected a Fellow of the Royal Society. The talents of such a man would have been in demand from those who felt they could afford his expertise. This was certainly the case for the aristocratic owners of Lanchester Common and Auckland Castle who engaged him to prepare maps of their grand estates. He may also have been kept from idleness by providing surveying services to the new gentry and yeoman farmers as they sliced up the land for enclosure. In a dictionary of practicing 18th century

land surveyors, it is conspicuous that Dixon's name is not included; so, perhaps after all, he was happiest amongst the tar pits and coal dumps of the family business.

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