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WHAT SHOULD AN OBSERVATORY LOOK LIKE? THE CASE OF THE RADCLIFFE OBSERVATORY, OXFORD

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Abstract: This paper argues that the design of the Radcliffe Observatory (1771–1798) was based on one form of Palladian country house which had become popular in the eighteenth century. The Savilian Professor of Astronomy, University of Oxford, Thomas Hornsby, had modest initial requirements for an observatory. But these initial requirements expanded into a building that memorialised John Radcliffe and the Radcliffe Trust (who funded the building) and provided considerable unasked for space for pomp and show for the University and Trustees. The tightly balanced Neo-Classical building that resulted is sometimes seen as an example of form following function, but it caused several problems for the astronomer, which could have been avoided if a simpler and less ostentatious building had been constructed.

Keywords: Radcliffe Observatory, architecture, Henry Keene, James Wyatt, Thomas Hornsby

1 INTRODUCTION

The Radcliffe Observatory, Oxford, is a spectacular building with a complicated history (Guest, 1991; Tyack, 2000; 2005; Walford, 2024). The building was designed to provide facilities for the Savilian Professor of Astronomy at the University of Oxford who was from 1763 to 1810 Thomas Hornsby (Wallis, 2000). It was mainly designed for fixed meridian instruments which measured the position of various bodies in the sky against time. While some provision for moveable telescopes for qualitative observation was made, this was never the primary purpose for the building for Hornsby.

The Observatory building is now part of Green Templeton College, Oxford, and consists in a central tower, some 90 feet high, set within a two-storey block some 46 feet high. At ground level there are two long single-storey wings on either side which stretch the length of the building to 175 feet.[1] Figures 1–3 show that the whole building complex originally had several interlinked parts. Figure 1 shows the South Elevation of the main building. The central door

Figure 1: South Elevation of the Radcliffe Observatory (photograph: Geoffrey Walford).

Figure 2: The octagonal entrance hall. The inscription on the sector above the door (which was originally a space open to the stairway) and opposite the main entrance reads: 'Munificentia Jophannis Radcliffe M.D.' (photograph: Geoffrey Walford).

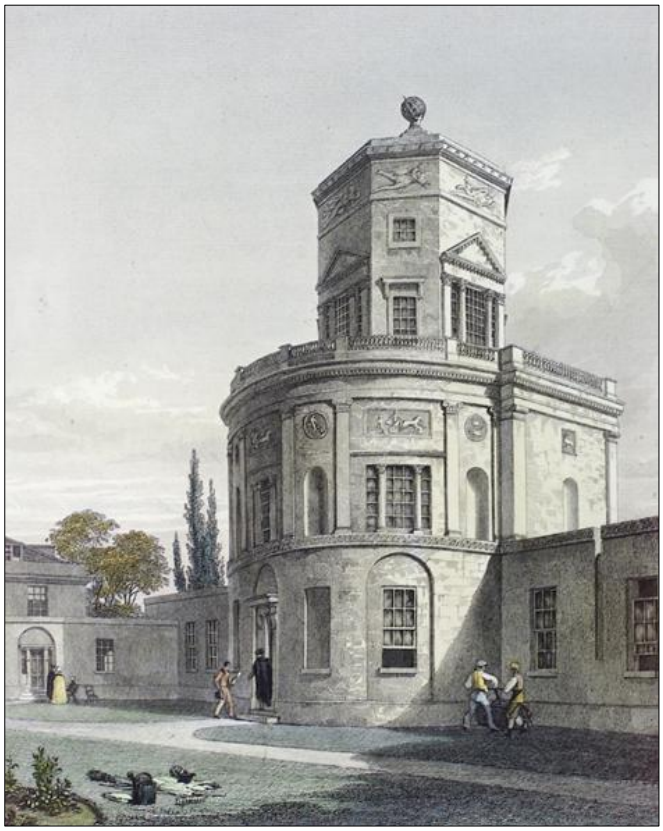

Figure 3 (left): "The Observatory, Oxford" engraved and published by T. and G. Hollis, 1836 (reproduced with the permission of the Principal and Fellows of Green Templeton College, University of Oxford).

originally opened into a large octagonal entrance hall (now a dining hall, Figure 2) and forward to a stretched-oval staircase and to rooms on each side of the hall and through to the wings. As can be seen, the wings also had separate central entrances on this South front. The whole building is constructed on an exact East–West axis as both single-storey wings housed astronomical instruments which had to be positioned so that they swung North–South. The West Wing was intended for student use, and the East was the research Wing for the Professor. What are no longer visible are the substantial shuttered slits cut in the walls and roofs (four on each main elevation) that enabled the telescopes inside the building to be used to observe and measure the positions of celestial objects. One of these slits can be seen on the right in Figure 3, which shows the North elevation and also the curved corridor that attaches the main building to the sub-

stantial Georgian Observer's House (left) and on to the kitchen and service parts of the complex and to the stables.

The Radcliffe Observatory had two architects—Henry Keene (1726–1776) who worked at the Observatory probably from 1771 until his death in 1776, and James Wyatt (1746–1813) who was probably involved in the design of a 'new elevation' in 1773 and became the overall architect in 1776 (Anonymous, 1752–1791). The difficulty of unravelling their detailed contributions has been discussed by Walford (2024), but the plan of the whole complex of the Observatory, the Observer's House, services, and the park-like setting was almost certainly the work of Keene.

2 PLANNING THE OBSERVATORY

2.1 Setting the Scene

On seeing the building for the first time, it is not obvious that the building is an observatory. While a separate domed building was constructed by Keene in the garden, the building has few of the tell-tale signs of what is now thought of as an observatory. Indeed, it looks more like a country house or a viewing tower than an observatory. This ambiguity is simply due to the fact that, in 1768, when Thomas Hornsby (1733–1810) petitioned the Radcliffe Trust for funding, there were few British models for what an observatory should look like (Rigaud, 1827–1849: 19). The architects of the building had to invent a new type of building with little to guide them.

The first Savilian Professor of Astronomy at the University of Oxford was appointed in 1619, but the University provided little to help him in his duties. Later Professors included Sir Christopher Wren (1632–1723), from 1661 to 1673, who designed the Royal Observatory at Greenwich but seemingly did not plan one for himself at Oxford. Later, Professor Edmund Halley (1656–1742) of comet fame and Savilian Professor of Geometry, built a simple box-like observatory on the roof of his professorial house in New College Lane, Oxford. But Halley complained about the lack of Instruments provided by the University, and the lack of space to store or use his own (Hutchins 2005). Other Professors used the tower of the Schools Quadrangle.

In the 1760s Thomas Hornsby (the tenth Savilian Professor) was able to use the enthusiasm generated by the transits of Venus in 1761 and 1769 (Orchiston, 2017) and King George III's fascination with science and astronomy to make a proposal to the Radcliffe Trust for them to fund a new Observatory and to purchase the best scientific instruments available to enable him to fulfil the duties of his position.

The Trust itself had been set up in the will of a high-society physician John Radcliffe who died in 1714 (Guest, 1991). There were several specific bequests that related to Oxford University and colleges including building a library, but the original Trustees were not drawn from the University as such and, once the specific bequests had been completed, they had the right to spend the profits from a substantial physical estate at Wolverton (now part of Milton Keynes) to support such charitable purposes as they thought fit. By 1768 the Trustees had built the Radcliffe Library, designed by James Gibbs, as instructed in the will, and the construction of the Radcliffe Infirmary built from the estate profits was coming to completion. It was time for a new project, and Thomas Hornsby (Rigaud, 1827–1849: 20–21) petitioned the Trust in a letter that proposed:

> … that a Professor together with his assistant, for it is not possible that the whole can properly be done by any single person, should be furnished with a set of the best Instruments that can be purchased & should be enjoined to make observations constantly, & at the end of each year to deliver a copy of such observations to the Delegates of the Press …

He then outlined a scheme where some students could obtain free tuition on a set of smaller instruments. The costs of such tuition would be borne by the colleges involved and would be spent on funding an Assistant Observer. In terms of the building, Hornsby claimed that he had examined what is done in the best observatories and laid out his needs for a house for himself and his family, a lecture room for his teaching, a room for occasional observations (of eclipses, comets, and other phenomena beyond the meridian), and two single storey buildings for the measurement instruments:

> I would propose therefore that as a House must be built for the Professor contiguous to the Building where the fixed Instruments are to be placed there be one large Room accommodated for the purposes of Expt. Philosophy, which as well as another immediately above it of the same size for occasional observations in any part of the Heavens (the other observations being all supposed to be made in a separate building to contain the larger Instruments which must be placed on the Ground & fixed in the plane of the Meridian) might constitute a kind of Tower to stand firmly on the Dwelling House. (Rigaud, 1827–

1849: 21–22).

But Hornsby's main concern was with the instruments he required as much as the buildings that were to house them. Hornsby wished to have constructed instruments that provided the greatest accuracy of measurement possible, and he wanted John Bird (1709–1776) the most respected instrument-maker of London to build them. As Chapman (1995b: 71–76) explains, Bird's outstanding innovation was that he developed a technique of dividing a 90° scale into equal parts using bisection alone—a method that could only be followed successfully by the finest craftspeople. Hornsby had bought two smaller instruments from Bird in 1760 and 1767 which were those he proposed should be used by students in the new observatory. But Bird was ill, had a full order book, and might not be alive long enough to finish the instruments if they were not ordered quickly (Chapman, 2000: 172). However, while the Trust informally accepted the request to fund the Observatory, they were not prepared to enter into a formal agreement until they were sure that the costs of the Radcliffe Infirmary had been covered. Hornsby thus engineered an extraordinary procedure by which the University Press loaned money for Hornsby to commission the instruments before the Radcliffe Trust had formally agreed to build and equip the Observatory.

Hornsby (1771) then circulated a document amongst Members of Convocation of the University of Oxford for a loan from the Oxford University Press (wholly owned by the University) to provide funds for the early construction of the instruments. The intention, and actuality, was that the Trust would subsequently refund the University. Hornsby claimed that Mr Bird was the only person living who could make the instruments with the precision and accuracy necessary, and listed the required instruments priced as nearly as he could calculate as £1300. These were a pair of eight-foot-radius mural quadrants in brass (both of which would have 96° and 90° scales), an eight-foot-long transit instrument, a twelve-foot zenith sector, and an equatorial sector which was to be housed in another separate building (Chapman, 1995a). The relationship between Bird and Hornsby was strong and long-lasting. Robbins (1930: 324) argues that Hornsby was the first to convince Bird of the advantages of achromatic object lenses even though these were heavier than the lenses he usually used, but this claim is challenged by Bennett (1993: 238, n.22). Hornsby also required items not to be made by Bird, including some achromatic refracting telescopes by Dollond, barometers, thermometers, levels, and a precision clock (Chapman, 2000: 172). There was urgency in making an agreement not only because of Bird's health, but because the Astronomer Royal also was thinking of ordering from Bird. The result was that the Delegates of the Press agreed to a loan to be paid back by the Radcliffe Trustees on terms to be agreed between Delegates and Mr Bird—even though no formal agreement had been made with the Radcliffe Trust at this point. An agreement was signed between John Bird (1771c) and the Clarendon Press on 2 March 1771. Only on 3 May 1771 did the Trustees ask for a Petition to the Lord Chancellor to be drawn up, and it was as late as 19 July 1771 when the Court of Chancery agree to the Trust's expenditure to purchase land, and

> … to build thereon a large and proper Observatory for reading of Lectures in Astronomy and to furnish the same with necessary instruments. (Senior, 1821).

The process of building a collection of the most advanced instruments in Europe can be traced by a series of 11 letters from Bird to Hornsby covering the period 1765 to 1772 that are held in the Royal Astronomical Society archive. As early as 29 January 1771, Bird is supplying estimates for the costs of constructing two 8 feet radius quadrants, a 12 feet zenith sector, and "… an Equatorial Sector with 5 ft. Dollond's Tel. and Circles of 3 ft Diameter such as the Astro. Roy is now about." (Bird, 1771a). He then gives a warning that "… unless you determine very soon the Astro. Roy will be before you …" (*ibid.*) showing that the competition from the Astronomer Royal was strong and the need for quick action from the university. A further letter from Bird on 9 February, four days after the Convocation vote, shows that Hornsby acted very quickly to give an order to Bird for the instruments, who agrees to not take on any other projects that might slow the progress of the Oxford instruments. He will "… endeavour to get one of the Quadrants ready for dividing in the Spring 1772, and, perhaps, the Transit in some forwardness." (Bird, 1771b). A further letter on 18 February 1771 deals with details of payments—all negotiated between Hornsby and Bird directly, but the Vice Chancellor is asked to pick up the bills (Bird, 1771c). By 5 May 1772 Bird (1772) says that all of the parts for the first quadrant (apart from some cocks) are ready to be put together, which he was to do in a specially constructed shed with care being given to temperature control. He also says:

> I hope you have now got the Ground for the Observatory secure, and that last week you laid the foundation, as I did: if so, it is a fair start, and I hope the Race

Figure 4: Interior of the Octagon Room over the Astronomer Royal's living rooms, a late seventeenth century engraving by Francis Place (Creative Commons).

> will be fairly run – odds against you. (Bird, 1772).

The friendly competition between completing the instruments and completing the building was a feature of their relationship.

Beyond the instruments ordered from Bird, Hornsby had a long shopping-list of other instruments that he required. These included a clock on Mr Harrison's principle "… to go without oil …", further clocks with compound pendulum, refracting telescopes of various object glasses and improved micrometers, a reflecting telescope, a small quadrant, a reflecting sextant, a small equatorial sector for use on the Observing Room, various stands for these instruments, barometers, thermometers, maps of the stars, globes, and more (Hornsby, n.d.). All of these had to be accommodated in the new Observatory.

It is of note that, as Chapman (2000: 171) argues, by 1772 John Dollond's achromatic object glasses were making it possible for powerful refracting telescopes to be constructed that were just four or five feet long rather than 20 or more feet. As these shorter telescopes developed, the tall windows and ladders of Greenwich would no longer be required, and by the time that Radcliffe Observatory's tower was finally fitted-out for use in the late 1790s, the tall windows, while they allowed telescopes to be moved onto the second-storey roof-space to explore objects high in the sky, were anachronistic in terms of most scientific research.

2.2 Existing Models for Observatories

Hornsby had few British models for what an observatory should look like. The most obvious was the Royal Observatory, Greenwich, which was designed by Sir Christopher Wren in 1675 on the instructions of Charles II, to provide accommodation for the first Astronomer Royal, John Flamsteed (1646–1719) and an Assistant (Laurie, 1964: 4). This structure was of two storeys with a basement, with four small rooms providing basic accommodation for the Astronomer Royal. The top floor, however, was an Octagon Room or Great Room (Figure 4) some 34 feet across and 18 feet high which "… was used on important occasions, such as the Board of Visitors Meetings, and for general observation." (Laurie, 1964: 5).

The Royal Observatory (Figure 5) was built cheaply on the site of an ancient moated tower of Duke Humphrey which had been demolished during the civil war. The sides were about 14 degrees out of line with the meridian, so the main building could not be used for quadrant work, and a separate small Quadrant House and Sextant House were constructed at the bottom of the garden. The Octagon Room was used for some observations, but the most useful part of the room for astronomy was that it had

Figure 5: Exterior of Royal Observatory Greenwich (Creative Commons).

a cavity wall in which the thirteen-foot pendula of three highly accurate clocks could swing and provide a greater vertical space for their driving weights (Kwan, 2010: 226). These long-pendulum clocks were essential for increasing the accuracy of timing and thus right ascension measurements and the value to navigation of the calculations. But, as Kwan (2010: 224) reminds us, Flamsteed knew that the Octagon Room was designed to serve as a space for "… pomp and show …" as much as for qualitative observations. The room was highly decorated and spacious and, while some shared convivial observations inevitably took place in it, it was a social space as well as a scientific one. This was true for the Tower of the Radcliffe Observatory as well—for James Wyatt's decorative scheme and ceiling within the tower (only finally completed in the mid-1790s due to an insufficient flow of funding) are highly impressive, and provided a fine chamber for receiving guests, who proceeded to the room via a comely semicircular stairway. Within the Tower, an internal balcony has four outward viewing windows placed between the cardinal points that would have been of little use for astronomers but provided a set of wonderful views of Oxford for visitors.

Kwan (2010: 230) shows that the idea that observatories naturally belonged in towers appears to have been well established during the seventeenth century. Observatories had been improvised in the tower of Wadham College and Christopher Wren himself was found in 1664 in the Tower of the Five Orders of the Bodleian Library using a telescope to try to see Mercury's transit of the Sun. In 1681 John Fell (1625–1686), Dean of Christ Church and Bishop of Oxford, asked Wren to make space for an observatory within the octagonal top of Tom Tower which he had designed (Curthoys, 2017: 115). Wren tactfully told him that his idea was outdated and that modern astronomy required a variety of measurement instruments that could not be accommodated in a tower observation room, and that

> … the best house will be a little house of boards about 12 foot square & 7 foot high & none other roofe but what may be taken quite off when the instrument is used …

would do as well in a garden as on top of a tower (Wren to Fell 3 December 1681, quoted by Kwan, 2010: 231). Wren, no doubt, would have recognised that, while a tower is not necessary for many observations, a clear horizon often is, and that is obtained by building towers or choosing to build observatories on hills.

At the same time that Hornsby was making his original request to the Radcliffe Trust, a different model for an observatory was being built at Richmond for King George III (1738–1820) so that he could view the imminent transit of Venus in 1769 (Figure 6). The building, which was once confusingly known as the Kew Observatory, is now greatly changed, but was designed by William Chambers (1722–1796) in consultation with the Superintendent Astronomer, Dr. Stephen Demainbray (1710–1782). They managed to build the Observatory within two years and the King was able to view the transit with clear skies in 1769. Originally, the building had a square plan on a North–South axis dominated by two octagonal rooms inside and canted bays on each of these fronts (Donnelly, 1973: 42). It followed the recent Swedish idea that the main telescope should be in a cupola on the roof. This idea had been initiated by Anders Celsius (1701–1744) in Uppsala in 1740, and Stockholm 1747–1753, showing the focus of these Observatories was not on meridian work. Apart from this, there is a clear similarity between the overall shape of the King's Observatory and the central portion of the Radcliffe Observatory. As Cloake (2009: 7) describes

> … the building was conceived as a small villa, similar to an earlier design by Chambers for a hunting pavilion ("casine") for Lord Bruce at Tanfield Hall in Yorkshire. It had a central block of two principal stories, with canted central bays of full height on both north and south sides, containing pairs for octagonal rooms, with single-story wings at east and west ...

Hornsby's initial design idea was most closely related to the situation at Greenwich, and it focussed on the provision of a tower consisting in a house for his family (of one or two storeys), a lecture room above, and an observing room on the top storey. This tower was to be positioned near to a separate building for the main instruments which had to be at ground level for stability, with another ground-level instrument building for student use. Hornsby's somewhat modest aims were presumably designed to make the proposal attractive to the Trustees by reducing costs, but their emphasis on modesty and practicality were potentially in conflict with the aims of the Trustees who eventually saw the Observatory as a further opportunity to memorialize Radcliffe and provide a building with spaces for pomp and show for Trustees, University dignitaries, and visitors, that reflected the status of its sponsors (Kwan, 2010: 232–241).

Figure 6: "Observatory, Richmond Gardens." Early engraving by W. Cooke, from drawing by S, Owen, detail (photograph: Geoffrey Walford).

3 THE RADCLIFFE OBSERVATORY'S ARCHITECTS

The Radcliffe Observatory complex has two named architects. Henry Keene worked on the building from 1771/1772 until his death in 1776, while James Wyatt probably had some input into the designs from 1773 onwards and took overall control from 1776 until about 1798. Henry Keene is less well known than James Wyatt, yet he was far from being an insignificant architect in central and southern England. Colvin (2008) states that he was the son of a builder and at age 20 he became Surveyor to the Dean and Chapter of Westminster Abbey and, in 1752, also Surveyor to the Fabric of Westminster Abbey. He retained these offices until his death. This regular contact with Gothic architecture enabled him to be one of the first to exploit the fashion for Gothic in the middle of the eighteenth century. For example, the vaulting of both the garden temple at Enville House (the Enville Museum, 1750–1752; Mowl, 1983) and the Hartlebury Chapel (completed 1750) were both related to the Henry VII Chapel in Westminster Abbey, as was the slightly later spectacular fan vaulting in Hartwell Church (1753–1755). Between 1762 and 1776 Keene made major contributions to the interiors of Arbury Hall, one of the major Gothic revival houses of the period (Musson, 2014) where the dining room fireplace is based on the tomb of Aymer de Valence (Colvin, 2008: 603). At Oxford Keene designed and built a Gothic fan-vaulted hall at University College (Tyack, 1998:182).

But Keene also built classical buildings and there are several pointers that he had an ambition to design and build classical country houses. He had built the Guildhall/Townhall for High Wycombe and was involved in many Classical conversions and additions to existing country houses such as Bowood and Hartwell, as well as working in Oxford Colleges such as Worcester and Balliol (1769–1770) where the distinctive Venetian windows on his Fisher Building were removed in 1870 (Tyack, 1998:182). Within Christ Church, Keene enclosed the ground floor of the library to provide an art gallery (1769–1772) using Venetian windows with unfluted Ionic columns with Grecian capitals (Bradley et al., 2023: 137). He also designed the Anatomy School (1766–1767) within Christ Church, which was described by Curthoys (2017: 152) as "… a simple, astylar box with unembellished sash windows and a plain par-

apet". It has a porch of paired Tuscan columns with a pediment. Externally, it was originally remarkably similar to the three by three bay House for the Professor that he built at the Observatory.

That Keene had ambitions to build country houses can be seen from some of his earlier drawings discussed by Mowl (1985: 82). The Victoria and Albert Museum has a collection of about 30 unbuilt designs for temples, houses and a palace.[2] In another paper (Walford, 2024) I have shown that this collection of drawings illustrates that Keene used octagonal shapes in many of his plans, and that they were far from uncommon in buildings of the period. Nearly all of the drawings are classical, although usually not following standard forms. While none of the drawings is signed, Mowl (1985: 82) identifies "… at least twelve of the temples and garden buildings are in his [Keene's] hand …" along with thirteen designs for medium-sized country houses. None of the classical drawings can be linked to any surviving or known buildings, but Mowl (1985: 90) argues that

> … it is not unreasonable to suppose that the main group of classical house designs were also early work, prepared by an ambitious young architect hoping to achieve, in the near future, the patronage of the wealthy.

He links them to what he calls Keene's first classical phase, from about 1755 to 1760. In some of these drawings Keene shows central octagonal entrance halls leading through to stairways to the upper floors.

The second named architect of the Observatory was James Wyatt, who is now much better known than Keene (for his 'destruction' of several Gothic Cathedrals; for his spectacular yet collapsing Fonthills; and for his magnificent Neo-Classical interiors). I have shown elsewhere (Walford, 2024) that other commentators have downplayed the importance of Keene in the building's design and given too much credit to Wyatt. Wyatt probably provided a 'new elevation' for the Observatory which was accepted by the Trustees in March 1773, but by that time the layout of the building complex as a whole had been decided. The length of the central building and the height of the tower were already planned and noted in *Jackson's Oxford Journal* (Anonymous, 1772) at the time of the laying of the Foundation Stone in 27 June 1772, thus before any possible involvement of Wyatt. In a letter between Hornsby and the Vice Chancellor dated 24 October 1771 Hornsby quotes a letter from Bird to himself (Rigaud, 1827–1849: 11–14) where Bird suggests that the following winter would be "… a proper time to prepare the stones, which if neglected I believe the buildings will not be finished so soon as will the instruments". The aforementioned "stones" were the massive concrete supports for the meridian quadrants and other instruments, and Bird is suggesting they be built during the winter that precedes the laying of the Foundation Stone, way before the consideration of a new elevation by Wyatt on 20 March 1773. Even if these stones were delayed for another winter, this would be before Wyatt's involvement, and the stones determine where the slits for the telescopes must be placed and thus crucial aspects of the design of the South front. The spacing of the stones determines the necessary length of each wing to make a symmetrical balance of windows, slits and doors.

As a new elevation for the Observatory (probably by Wyatt) was adopted in March 1773 it is not clear exactly how much of the building should be ascribed to each architect through to Keene's death in 1776. That the Radcliffe Observatory is often seen as a major example of the architecture of James Wyatt, has meant that praise has focussed on the tower which was decorated externally with some motifs from the Tower of the Winds in Athens (e.g. Colvin 1986: 849–850; Robinson 2012: 197). The design of the windows and exterior decoration, but not the basic shape, of the tower was certainly Wyatt's but, in fact, the only similarities are that the tower is octagonal (although not an equilateral one, and considerably larger), there are carvings of the eight gods of the winds, and the ground floor has a porch very similar to that at Athens. Inside the tower, however, Wyatt produced one of his richly decorated Neo-Classical rooms fit for entertaining and for occasional observation (Figures 7 and 8). But this focus on the tower has distorted understanding of the complex as a whole, for the most important part of the Observatory as such was the East Wing built by Henry Keene where the quadrants, transit and zenith Instruments were housed alongside clocks, barometers, thermometers, and related scientific apparatus. As shown in Figure 8, the central tower was designed more for entertaining and pomp and show than for any serious astronomical work (Kwan, 2010).

4 KEENE'S DESIGN

4.1 The Country House Model

It is worth recognising the nature and scale of the difference between what Hornsby originally asked for and what he ended up getting. The initial estimate by Hornsby was that the cost to the Trust would be about £6,000–7,000 for the building and Instruments, but the actual cost was

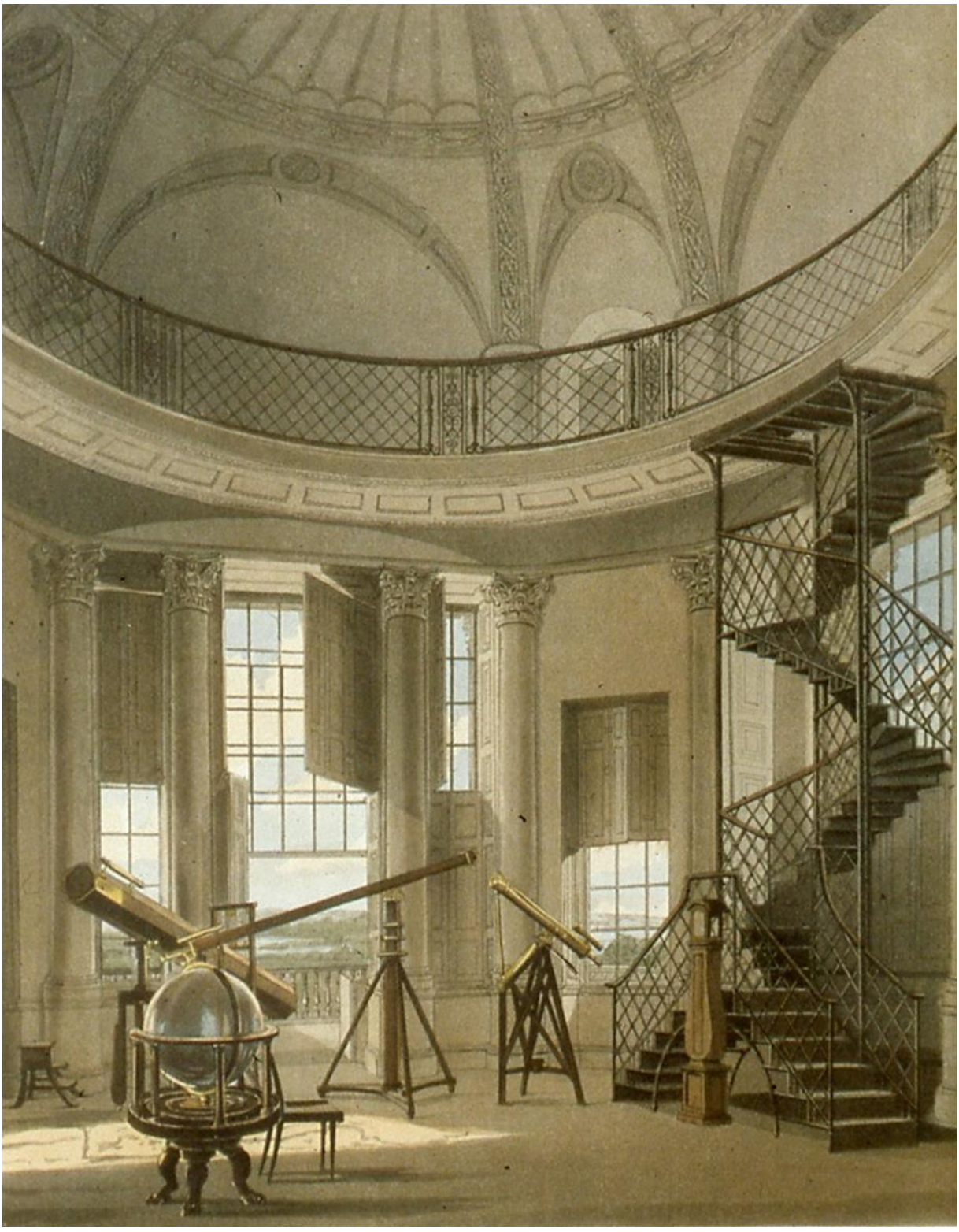

Figure 7: "Astronomical Observatory." Etching. London, Published 1 February 1814, for R. Ackerman's *History of Oxford*. Showing the "room for occasional observation" (reproduced with the permission of the Principal and Fellows of Green Templeton College, University of Oxford).

more than £31,000 (Anonymous. 1792–1815: 18 May 1799). Buildings designed to impress frequently over-run initial estimates, but here much of the extra cost was due to the Trust providing far beyond Hornsby's requirements. This funding to excess is strange for there is little evidence of extensive involvement of any of the members of the Trust in astronomy, in the building process, or of Trustees even visiting the site during building except for the laying of

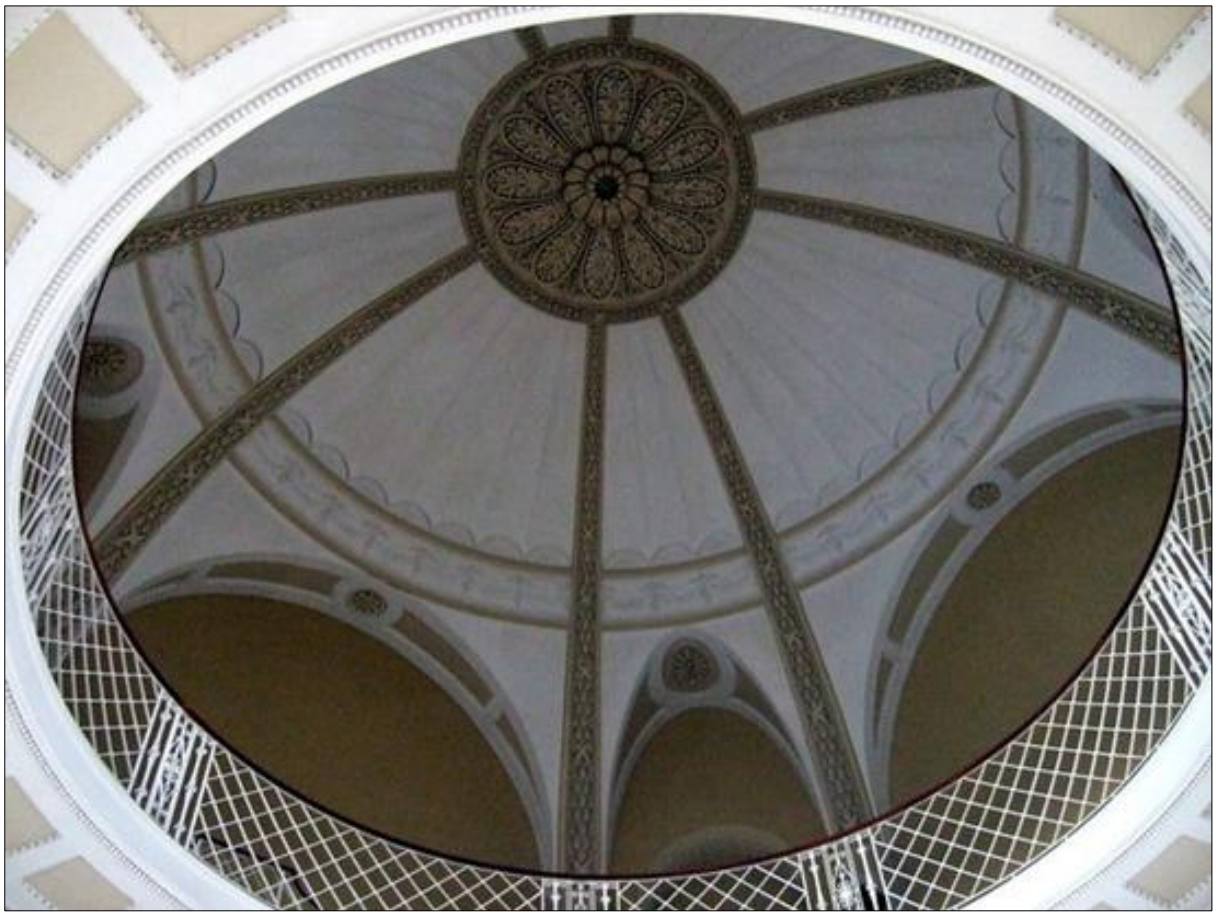

Figure 8: "Radcliffe Observatory: Inside the Cupola" (Creative Commons: ceridwen).

the Foundation Stone. All of the relevant meetings of the Trustees were held in London. It must have become evident to Keene and later to Wyatt that the Trustees wanted the Observatory to be an impressive building that would be another memorial to Radcliffe and that they were prepared to pay substantially more than initially requested by Hornsby to build a memorial for pomp and show. Hornsby must have agreed to the idea that the Observatory should serve a variety of purposes, and various letters (e.g. Wyatt, 1775) show that he was centrally involved with negotiations over the construction and decoration of the building as well as the strictly astronomical and accommodation parts of the building (Walford, 2026).

While most commentators have focussed on the idea that the tower has some affinity to the Tower of the Winds, I wish to argue that the most significant aspect of the overall design of the building is that someone, sometime in 1772 or probably earlier, realised that all of the requirements for the Observatory laid out in Hornsby's original request for funding could be brought together into a significant architecturally-balanced Neo-Classical building that looked and performed very much like a country house. The decision to separate the Astronomer's House and form a satellite to the main building was presumably made, or at least agreed to, by Keene, the Trustees, and the Hornsbys together. By moving the family accommodation away to the side of the complex and attaching it to the main building by a curving corridor, the main building could make a statement about enlightenment, rationality, and science through its Classical symmetry. Rather than see the Observer's house as the centre of the complex, Keene's design combined the required parts of the building into a 'country house' where a central two-storey building with a tower above provided a lecture room and a room for occasional observations, and the two wings for astronomical instruments were attached either side. The lower parts of the central building could provide a magnificent entrance hall with staircase leading up to the lecture room and up again to the observation room, as well as to the rooms used for observation in the two ground-floor wings. The Observer's house was then attached to one of the wings as a 'pavilion'. Again, it is noteworthy that a large entrance hall was not requested by Hornsby, nor were any of the four fine rooms with apses, fireplaces, and barrel-vault ceilings that are placed either side of the

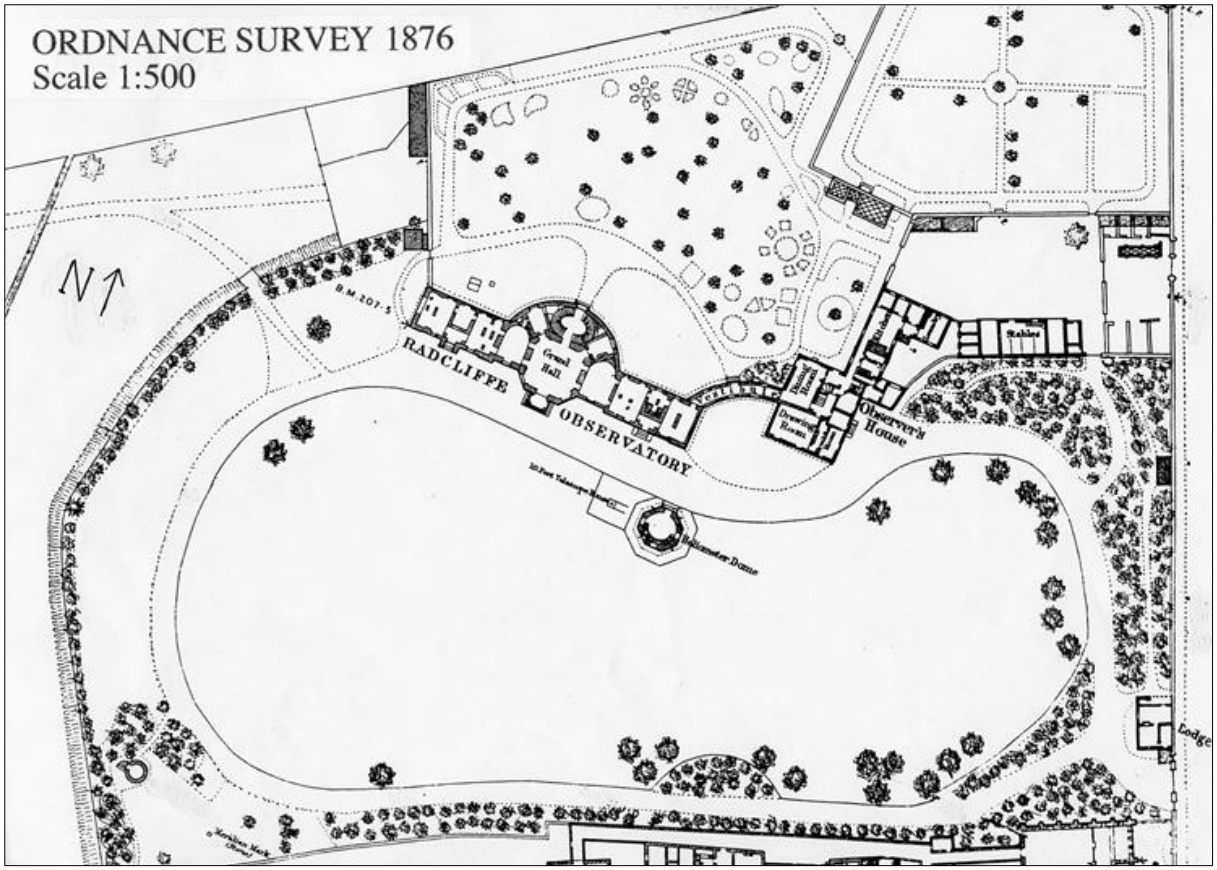

Figure 9: Detail from First Edition Ordinance Survey map 1876 (courtesy of Green Templeton College).

octagonal entrance hall (on the ground floor) and corresponding lecture theatre (on the first floor). These rooms are simply 'pomp and show' rooms. As I shall show, this arrangement of rooms and functions and the positioning of the whole in a park is modelled on a currently fashionable type of Palladian country house.

The resulting distribution of the parts of the building is shown in Figures 9 and 10. The site for the Radcliffe Infirmary had been chosen to benefit from the cleaner air to the North of the city, and the Observatory site was just North of the Infirmary at the edge of the city and countryside so that it too would benefit from the clearer skies. The site also bordered what is now the Woodstock Road on the eastern side which was the main road to Oxford from the North.

In making the decision to design the Observatory in this manner, Keene was, whether he acknowledged it or not, following Andreas Palladio (1508–1580). Beltramini (2020: 5) states that "Palladio was a visionary who aimed to improve people's lives with solid, functional, beautiful buildings." His villas were "… endowed with good logistics in both internal circulation and the accesses from outside." Especially with his villas that spread around Vicenza, Palladio's buildings often combined the dual aspects of a farm house (always a somewhat romantic idea (Holberton, 1990: 156ff), and more of an early form of *ferme ornée*) with those of a house for living, entertainment, and display. One of the most cited is Villa Mocenigo/Mocenico (Palladio, 1738: 2, Plate 58) where four farming-related areas are swept from the central block by quadrant colonnades. Villa Barbaro, Maser, was smaller with a central block linked to two symmetric wings (Tavernor, 1991: 30, 47). Other unbuilt villas such as Villa Thiene, Padua, and Villa Trissino, Vicenza, also show central blocks joined to smaller wings (Holberton, 1990: 116, 119).

While Palladio combined farming with living, entertainment and show, Keene was not the first in England to combine various functions and to look towards Palladio's villas as models. Thomas Coke (1754–1842) of Holkham spent most of his life building his Hall with just one of the four attached buildings being used for the family home (Hiskey, 2016). The central part of building was used here for display of Coke's art collection from the Grand Tour, and for entertaining. Similarly, at his Kedleston Hall, Nathaniel Curzon (1726–1804) had a central core devoted to display, and he intended to have four wings attached to the core by quadrant corridors. Only two were built—the Family Wing and

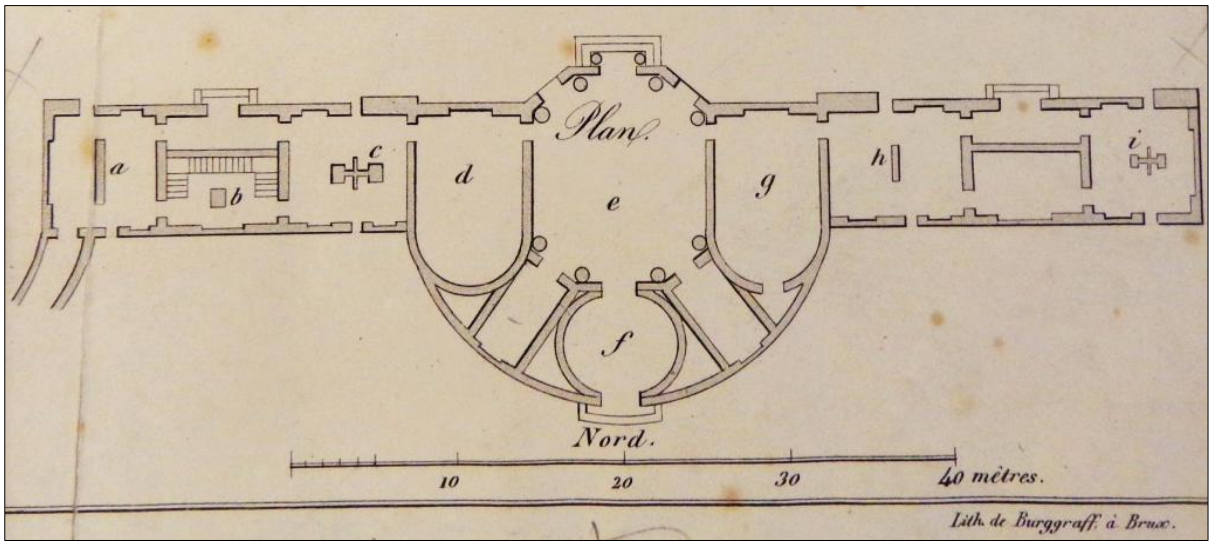

Figure 10: Plan of Radcliffe Observatory Oxford, probably about 1830. South is at the top. a = the mural quadrants; b = the zenith sector; c = the transit instrument; h = the mural quadrant (teaching); i = the small transit. MHS. 'Perspective de l'Observatoire d'Oxford', Lith. De Brggraff a Bruso, Ref: 87296. Astronomical Observatories 002 (courtesy History of Science Museum, Oxford).

the block based on the kitchen (Harris and Banks, 2003; Murray et. al., 1999). As with many country houses that were built to house and display collections, the Observatory was built to house, display, and use a collection of scientific instruments.

4.2 Who Else May Have Influenced the Design?

Recent increased interest in women's role as architects and architectural patrons (e.g. Barre 2022; Boyington, 2024; Dooley et al., 2018; Sands 2022) forces us to consider whether Hornsby's wife may have played a part in the decision to separate the house from the lecture theatre and room for casual observation. Hornsby was appointed Savilian Professor of Astronomy in 1763 and was then able to marry and move into the Professor's house in New College Lane. He married Ann Cherrill the same year and during the first twenty years of their marriage they had twelve children, five of whom survived beyond infancy (Wallis, 2000: 222). The New College Lane house backed directly onto the old city wall and was built in the seventeenth century and re-fronted in the eighteenth. Next door a previous Savilian Professor of Geometry, Edmund Halley, had built a small observatory on the roof so that visitors had to climb the stairs through the house to reach it (Graham, 2015: 75). In 1768 the Hornsbys' first child had died, but their son Thomas had been baptised in January 1766 and survived. The benefits of separation of the observatory and the family home must have been immediately obvious to Ann even if they were not obvious to Thomas.

As Boyington (2024: 26) argues,

> when a new country house was commissioned or an existing house was substantially remodelled, spousal collaboration was often integral to the success of the project.

Vickery (2009: 130) argues that women had a large part in interior design from the sixteenth century onwards, while Cornforth (2004: 206) says that this was later in the 1720s, and Saumarez Smith (1993: 233) gives an even later date of 1760. While it was mostly men in the eighteenth century who controlled the money to build houses and what went on in much of the house once it was built, the various essays in Hague and Lipsedge (2022), for example, show the complex negotiations that must have involved both men and women in most building projects involving domestic space.

Hornsby's plan was to have a house, with a lecture theatre above and then an observing room above that. Such an arrangement was highly unsuitable for a family residence, and Ann Hornsby may well have raised objections. She must also have seen the new Dwelling House as a potential step upwards in status and comfort and probably fought for a design that gave the family an impressive, comfortable house with some privacy. While Greenwich Observatory had accommodation for the Astronomer Royal and for two Assistants to sleep in rooms on the ground floor, such an arrangement would have been very inconvenient for the Oxford Astronomer with wife and children and who were undoubtedly aiming for a sizable family.

Other influences on the design may have come from the Trustees themselves. The leading aristocrat of the Trustees from 1755 until his death in 1772 was George Henry Lee II, 3rd Earl of Litchfield (1718–1772). His family home was Ditchley House which was build from 1720 onwards for George Lee I, 2nd Earl of Lichfield (1690–1743), by James Gibbs (1682–1754) and Francis Smith (1672–1738), with interior décoration by William Kent (1685–1748), Henry Fitcroft (1697–1769), and others (Friedman, 1984: 318–319; Gomme, 1989). Although on a scale far greater than the Observatory, Ditchley had two pavilions linked to the central building by curving corridors. It was the 3rd Earl of Litchfield who, just before his death, is said to have called for another 'elevation' from a second architect —almost certainly from James Wyatt (Anonymous, 1752–1791: 20 March 1773)—and it is highly possible that he, and the design of his family home, had an influence in Keene's plans as well. Whereas at Ditchley the two pavilions are thrown forward of the South front, at the Observatory the single pavilion is thrown back from the South front. As can be seen from the plans of the site (Figure 9), this makes far more sense given the need for an East–West orientation, and allows the Lodgings to have an entrance that faces East at an angle towards the main road yet still be aligned with the meridian.

5 EXPLORING THE DESIGN

5.1 The Main Building

In the original plan of the Radcliffe Observatory, Keene (or Keene plus the Hornsbys and possibly Lord Litchfield) produced a single, balanced Neo-Classical building that served the needs of teaching and research, provided comfortable lodgings for the Professor of Astronomy in a park-like environment, and also provided space for pomp and show for esteemed visitors. There is little doubt that, at this point, the building had to be Classical and symmetrical for astronomy was mathematical and balanced—it was about trying to understand the geometry of the Universe, to see the symmetry of gravitational pulls between the stars, planets and other objects. The building had to reflect this orderliness and symmetry, and Classical symmetry achieved this perfectly.

The various functions of the building were delineated in space, yet conveniently brought together. Students could access their West-Wing facilities directly from a separate South-front entrance, as could visitors to the East-Wing research instruments. The utility, practicality, and good design of these Wings should not be missed. Each Wing entrance leads to a small entrance hall that then leads into a room on either side forming part of the enfilade of doors. The Astronomer had easy access to his house which was attached to the East Wing, while he (and probably the Trustees) could entertain special guests and dignitaries via the central doorway of the main structure, into a large 30-ft across entrance hall, stairway, and series of show rooms on the first floor, culminating in the tower room. This central doorway and promenade also served those who visited for lectures on the first floor. Although there is no evidence of any planning for further semi-detached satellites, the Observatory is positioned in the plot such that a further three linking and geometrically-balancing satellites could have been built in the future.

The idea of a *piano nobile* (floor with the principal rooms) may not be particularly appropriate for the Observatory, but if the ground floor is conceived as the *piano nobile*, there are ten doors lined-up on the South side (some single, some double) that link 11 rooms in an enfilade 175 feet long. Barczewski (2023: 250) argues that many country houses were display sites for materials gathered by conquest or through collecting while abroad. The telescopes and other scientific instruments that this ground floor housed might then be seen as comparable to the paintings of Joshua Reynolds (1723–1792) or Thomas Lawrence (1769–1830), or the sculpture of Antonio Canova (1757–1822), that can be found in other country houses. Hornsby had negotiated with Bird and made suggestions for improvements so that Bird could construct the very best instruments available at the time. Hutchins (2005: 64) simply states that

> … when completed in 1795 the Radcliffe Observatory, because it also contained the best state-of-the-art suite of research instruments, was beyond doubt the finest observatory in Europe.

The main instruments were two eight-foot-radius mural quadrants, an eight-foot-long transit telescope, a twelve-foot-long zenith sector and an equatorial sector housed in its own separate building. Uniquely, they were fitted with Dollond achromatic object lenses (Chapman, 2000: 172). While these instruments were obviously designed and used for scientific purposes, they were also objects of beauty and rarity (one quadrant is still displayed on the stair-way at the History of Science Museum, Oxford) and the audience for their display would have included the gentlemen within the University interested in the latest and best scientific instruments and others drawn from outside the University. These might be similar to the 'Lunar Men' (Uglow, 2002) who pursued scientific interests, and with whom Sir William Herschel (1738–1822)

Figure 11: The first floor East barrel-vaulted room. Now used as a Fellows' Room (photograph: Geoffrey Walford).

was associated. Hornsby and the Radcliffe Trustees would have wanted the high quality of the instruments and building to be on show to select guests in a similar way to Coke displaying his Claude Lorrain pictures at Holkham. The Observatory is not only a place for scientific investigation of the highest order, but also an example of a country house as a Treasure House (Coutu et al., 2023: 5; Jackson-Stops, 1985; Mandler, 1997).

It is worth pausing to consider that the main building would have been almost largely a male preserve. The lecture theatre and instruments in the West Wing were designed for the students and Fellows of the colleges. Except for times of pomp and show few women would have been present, and while some women may have climbed the stairs to the second floor to be shown the views of Oxford and of the planets and star formations, it is highly unlikely that many would have climbed the narrow staircase to the internal balcony of the top observing room. All windows had internal shutters with no curtains. Only the family satellite would have regularly been used by women.

In order to make the central part of the Observatory building balanced, Keene had to introduce some rooms that were not initially requested. The central five-bay block is of two storeys and has six main show rooms, three on each floor. On the South front the middle three bays delineate the octagon, and provide the entrance hall with the lecture room above. It is likely that Hornsby had little use for this massive unheated entrance hall. While it raised the height of the tower and provided a separate lecture room, the latter could just as well have been positioned on the ground floor.

These spaces for pomp and show were highly flexible. There were multiple doors linking and separating the various rooms. On the ground floor the two large and well-decorated and heated rooms on each side of the entrance hall are usually designated as 'offices' with little justification, but those on the first floor in particular initially seem to have little practical purpose. All four are spacious, well decorated, and fitted with wooden shutters on the windows. The walls opposite the window in each of these four rooms are apsidal with curved fireplaces (largely of wood imitating marble) fitted in the centre of each apse. All four rooms are barrel-vaulted, and seem to be waiting for some delicate Neo-Classical decorative scheme to be installed. The two on the ground floor could be used as continuations of the wings at one time, but as 'show rooms' linking to the entrance hall at other times. Although sometimes designated as storage rooms, the two barrel-vaulted rooms on the first floor are simply too grand to be intended for this purpose (Figures 11 and 12) and

Figure 12: The barrel-vaulted room and apsed room on the West first floor. Now used as a small dining room (reproduced with the permission of the Principal and Fellows of Green Templeton College, University of Oxford).

there is no need for further offices on this floor. When Wyatt was asked on 27 May 1797 to provide furniture for the Observatory the Trustees requested each of these two rooms to have a table and six chairs, with a grate (Anonymous, 1752–1791: 27 May 1797). Their main purpose seems to be to provide further rooms for entertainment, and to ensure that the external massing of the parts of the building is balanced, so that the single-storey wings can be held by a substantial central core, and the tower not look too tall and unbalanced. Their presence also emphasises that the top of the balustrade on the central core is almost exactly half the height of the top of the tower walls. But it may be that these top barrel-vaulted rooms also provide some buttressing for the tower. Rather than having external flying-buttresses, here the weight of the tower may be distributed through internal buttresses. The two first-floor rooms are now used as a Fellows' Room and as a small dining room (Figures 11 and 12). Some commentators have designated this first floor as the *piano nobile,* but it might be equally informative to see the vertical progression from entrance hall, to the first floor, then up to the tower with its internal balcony as a vertical *piano nobile*.

While there is considerable physical décorative evidence that the six main central rooms, the staircase, and the tower room were designed as show rooms, it has to be admitted that there is little other evidence beyond the building itself that indicates the need for rooms for entertainment and pomp and show. One small indication much later that the Trustees may have enjoyed some elements of show is recorded by Robbins (1930: 323) who describes some of the curiosities on show in the then library (housed in the Lecture Room), including "… the silver mace with its serpent and bull's head carried on ceremonial occasions before the Trustees." A further possibility for entertaining visitors is that they might be able to 'walk the leads' of the Observatory in the same way as many country houses. The windows of the tower room can be opened such that telescopes and people can access the roof over the two first-floor barrel-ceilinged rooms (way over the void above the barrel vaults). But moving the telescopes would have been both difficult and unnecessary for all but the highest objects in the sky, while to be able to 'walk the leads' was a favourite entertainment in many country houses. Bess of Hardwick (1521–1608), for example, had a small banqueting house positioned on her roof so that walking the leads and admiring the view became a central part of after-meal entertainment (Girouard, 1983: 157; 1989: 36). At Longleat in the 1560s Robert Smythson (1535–1614) designed a whole series of banqueting rooms in

turrets on the roof (Girouard, 1983: 48–49). But perhaps a more substantial piece of evidence for the intended use of the central part of the Observatory comes from history. In April 1749 the Radcliffe Trust and University had set a precedent for celebration, over-indulgence, and pomp and show when the Radcliffe Library was officially opened. The ceremonies were spread over four days and are estimated to have cost (an unlikely) £20,000—compared with about £40,000 for building the Library itself (Hebron, 2014: 55–57). However, there is no remaining evidence found that indicates any similar celebrations when the lengthy building process at the Observatory finally dragged to its end in the late 1790s.

5.2 The Country House Setting

Pirie (2005) has examined the nature of the garden layout of the Observatory. He writes:

> At the outset, the value of the grounds accorded with the distinguished architecture deemed fit for an eminent astronomer, justifying the creation of a landscape park and all the accoutrements of a small country house. (Pirie, 2005: 45).

Further, he mentions that in relation to Oxford college buildings the Observatory's gardens were created at a time near the middle of a large gap in the founding of Worcester College in 1714 and Keble College in 1870 and that in terms of accommodation it was more like a country house than a collegiate institution (Pirie, 2005: 31). He links the design of the garden to changes in contemporary garden design towards the landscape gardening of Lancelot 'Capability' Brown (1716–1783) and Humphry Repton (1725–1818) which was flourishing in country houses. But he does not recognise that the building itself is also designed following a particular Kedleston or Palladian country house model where a satellite residential block is set in line with the central building.

The North and West walls enclosing the whole premises and the walled garden were probably built from May 1776 onwards following an Order at a Meeting of the Trustees, but the size and shape of the walled garden were probably planned earlier as the South wall of the garden formed the North wall of the stables yard which had been completed by this time. The walled garden is six-sided and irregular so that it aligns with the Woodstock road, the stables, and the meridian line. The outer walls are substantial, dressed-stone-covered, and at least 1.5 feet thick, standing from eight to twelve feet high. The two entrances to the Observatory are marked by stone-work gate piers. The wall was continued on the North and West sides of the site, with the wall of the Infirmary providing the southern boundary. This must have been an enormous expense, and taken a considerable time to complete given that the Trustees had restricted costs to £1000 per year at this point (Anonymous, 1752–1791: 15 May 1776). The cost of this wall is one of the reasons why it took over 25 years to finish building the Observatory. As McCarthy (2016: 8) states:

> Arrival at a country house invokes feelings of anticipation and expectation in the visitor. The walls surrounding private grounds protect the mystery and exclusiveness of the place and the privacy of the owner.

The first record of the Trustees paying for shrubs and trees to be planted occurs in the accounts for February 1776 when Mrs Eliza Tagg, Nurserywoman is paid (Anonymous, 1752–1791: 15 May 1776; cf. Pirie, 2005: 33). A drawing by a local artist John Malchair (c. 1730–1812) dated 9 January 1778 indicates that some of the planting was used to try to hide the view of the hospital buildings from the Observatory to give a greater enclosure and park-like feel to the grounds (Harrison, 1998: cat31).

As discussed above, Thomas Hornsby had a long-term working relationship with the 4th Duke of Marlborough (1739–1817) who was a keen scientist and astronomer.[3] When Hornsby appealed to the Radcliffe Trust for funding, it was initially unable to formally agree as it was still paying for the Radcliffe Infirmary. A 'gentleman's agreement' was made and, in November 1770, the Duke stepped in to find a plot of land that was suitable for the Observatory. He took a twenty-year lease from St John's College (with licence to alienate) with the intention that the Trustees would take over the lease (and later purchase the site) once they were able to do so. It is this same Duke of Marlborough who married Lady Caroline Russell (1743–1811) in 1762 and who then set out to transform Blenheim into "… the most fashionable and splendid family home." (Bapasola, 2009: 55). This included the magnificent landscaping of the 2000-acre park by Lancelot Brown who worked at Blenheim from 1763 to 1774 (Brown, 2012:149). There is no suggestion that Brown worked at the Observatory—the site could comfortably fit about 12 times into the 110-acre lake at Blenheim—but the elements of Brown's style are evident and both Hornsby and Keene would have been well aware of Brown's work. The Observatory has a sweeping lawn on the South that reaches close to the building, there are strategically placed trees and bushes delineating views, and a

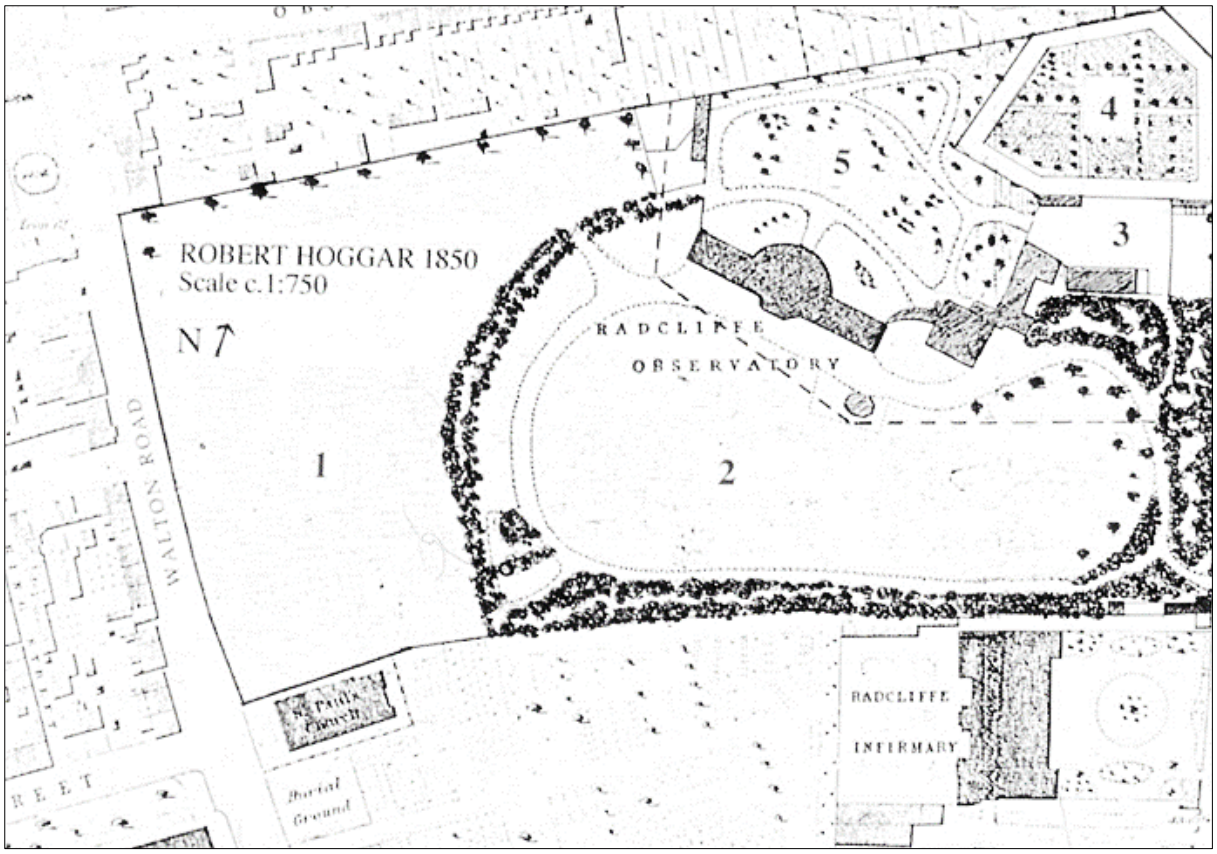

Figure 13: Detail from map of Oxford by Robert Hoggar, 1850. There are some errors in depicted alignment of walls, and in the quadrant corridor—see Figure 9 (courtesy of Green Templeton College, Oxford).

screen of trees surrounding the park, paths are curved rather than straight, and a ha-ha is used to give the impression of more land being part of the park.

That the Observatory might be conceived as a country house can be seen in Figure 13, which gives a detail from a map of Oxford by Robert Hoggar (b. 1791) of 1850. By this point, the northern wall of the park had been adjoined by a row of houses (Observatory Street) but, when it was built, the Observatory was at the northern tip of Oxford, just beyond the Radcliffe Infirmary to its South, and open to fields and countryside. Figure 13 shows the allocation of space (by number) to the five areas of pasture, park, stable yard, kitchen garden, and Astronomer's private garden. It can be seen that there was envisaged some degree of self-sufficiency with provisions from the kitchen garden and space for grazing of animals. In most cases the land that supports a country house is contiguous with the park, but here the Radcliffe Observatory was totally supported by the 2500 acres of good farmland held in trust by the Radcliffe Trustees, at Wolverton now in Milton Keynes.

The details of the quadrant link, offices and walls of the kitchen garden are incorrectly drawn in Figure 13 and shown more accurately in Figure 9 of 1876, which correctly indicates the North–South orientation of the East walls of the garden, and elements of the Service Wing. It shows the layout of the whole complex in detail including the internal layout of the Observatory and house, the walled garden, Observer's garden, park, service buildings, and stables. By this time a Victorian lodge had been constructed at the main park entrance. A slither of land to the South had also been given to the Infirmary to allow access and for a hospital chapel. This map shows clearly the way in which the whole Service Wing deals with the necessary change in orientation from that of the main road and stable-yard entrance and the rest of the 'country house'.

Figure 13 also shows that the Observatory itself is sited such that there is substantial parkland to the South and an adequate private garden for the Astronomer to the North. The alignment of the buildings, including the house and the services building is East–West/North–South. Only the stables, which included two Diocletian windows, were aligned at right-angles to the road. The figure shows that there were two entrances to the site from the Woodstock Road. The main entrance is to the very South–East of the site, while the entrance for trades-

people and to the stables was near to the North-east corner just South of the walled kitchen garden. At the main entrance a clump of trees hides the direct view of the Observatory. The pathway splits into two scenic journeys around the park. Carriages are able to follow a westerly path where changing and impressive views of the Observatory appear before them and draw-up outside the South entrance to the Observatory, or take a shorter northern path more directly towards the Astronomer's House. Either way, the service parts of the House and the Stables beyond are shielded from view by trees and bushes.

To the West of the park is the meadow which is separated from the park by a ha-ha and, by 1850, also by trees, and to the North of

Figure 14: An undated photograph of the Equatorial Sector House (courtesy of the Radcliffe Trust).

the Observatory are the Astronomer's private gardens with links through to the stables area and to the walled garden. The meadow was designed for grazing cows and the walled garden for fruit and vegetables, giving the house a degree of self-sufficiency. The whole land area is only about nine acres in all, but it shows all the features necessary for a country house or villa. It is important to note that the Astronomer's House is aligned East–West in a similar way to the Observatory. The entrance to the House faces due East; it does not attempt to align itself with the Woodstock Road. The attached Service Wing is aligned with the house on one side but an internal, walled yard curves such that the linked stables are aligned at right-angles to the Woodstock Road. The Observatory is thus not an afterthought to the House (or *vice versa*), but integrally linked to it in conception. It would have been perfectly possible to have had the house, lecture room, room for occasional observations, and various service buildings separate from the two single-storey rooms for meridian observations. Together they would have made a substantial building facing the Woodstock Road, providing an impressive visual northern entrance to Oxford, but this possibility was not taken.

Geometry was also important in the sitting of many country houses. At nearby Blenheim Palace the South front is aligned and centred onto Bladen Church tower. At Stowe, Buckingham, the alignment of the South front was originally on the Parish Church of Buckingham. Sadly, the church was destroyed and a new church built a little distance away, so the view South from the Salon, through the South portico, is now disappointing as the distant Corinthian Arch no longer frames the church spire. At Winchester Charles II (1630–1685) aligned his new palace with the Cathedral, while Lord Bathurst (1762–1834) used the church tower and spire as his focus at Cirencester (Borsay, 1989: 89–90). For the Observatory the key distance focus was a marker that indicated the meridian—in this case a metal line attached to the wall of the buildings of Worcester College some 682 yards due South of the Observatory (Guest, 1991: 242), where Keene was also working at this time.

The park also had a characteristic Georgian garden building. As Rutherford and Lovie (2012: 5) state, while Georgian garden buildings are sometimes regarded as simply decorative follies, most of them had specific functions ranging from gate-houses and accommodation for staff, to summerhouses and banqueting houses. It was in keeping with this philosophy that a functional building to house the equatorial sector (which was an instrument requiring a wide view of the sky) should be designed to emulate the Temple of Romulus in the Roman Forum (Chapman, 1995a: 440–441; Pirie, 2005: 34). Figure 14 shows what might be considered as the first 'garden building' or 'folly'. This building was situated away from the main buildings and it gives an alternative focus to the garden (Bapasola, 2009: 60). It is highly likely that Henry Keene saw this relatively small building as giving him the chance to build a garden building, for he had designed many such buildings over his career. Keene's other garden temples included the fanciful 'Turkish Tent' at Painshill which was in place by 1760 (White, 2023: 111), but he also probably designed the 'Museum' at Enville Hall, Staffordshire, had a part to play in Robin Hood's Hut at Halswell House, Somerset,

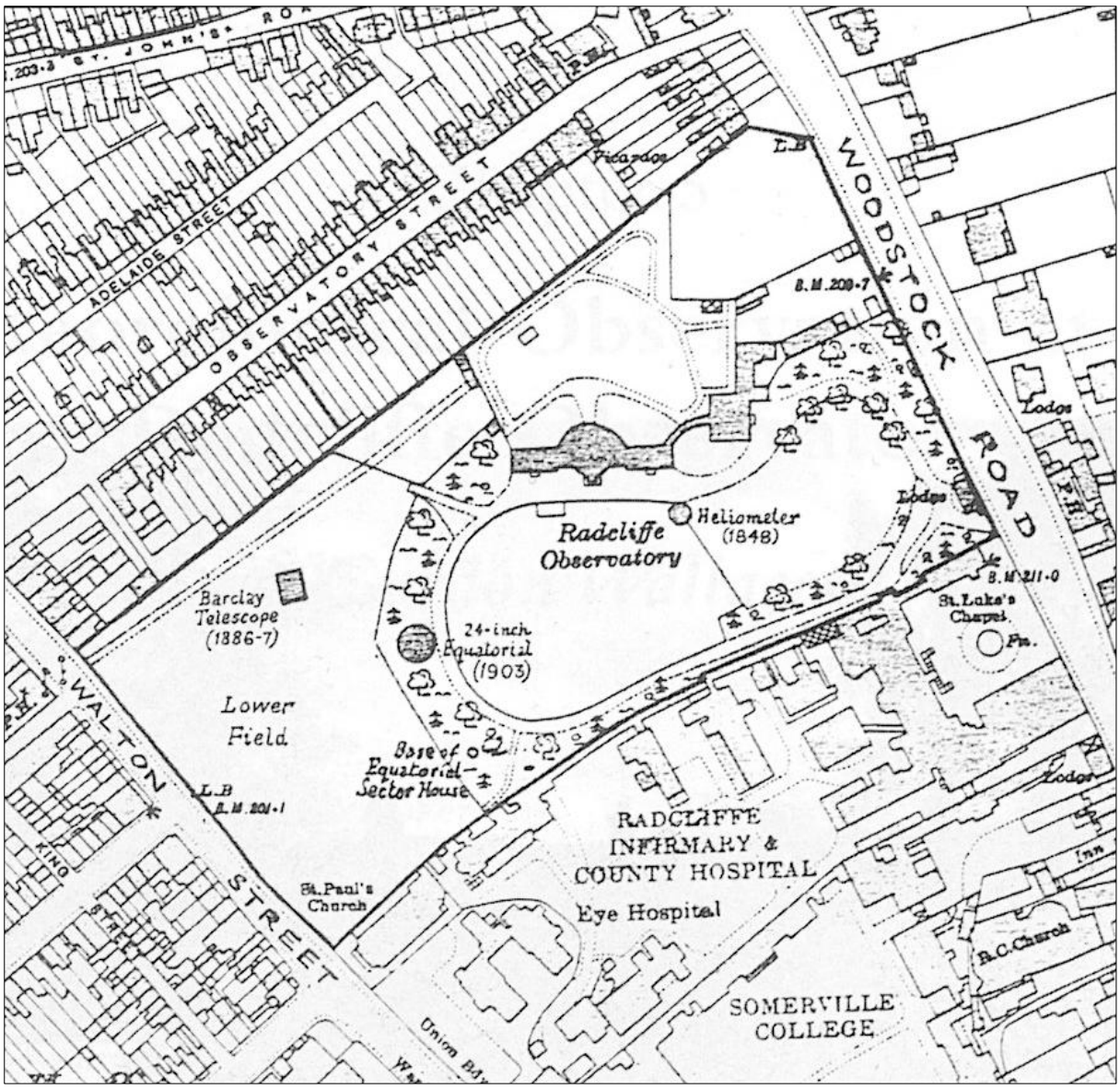

Figure 15: Map showing distribution of 'garden temples', adapted from Ordinance Survey map of 1887 (courtesy of the Radcliffe Trust).

and certainly designed the striking St Mary's Church at Hartwell House, Buckinghamshire, which emphasised its role as a garden ornament by having both an East and a West tower (White, 2023: 274). The collection of Keene's drawings at the Victoria and Albert Museum also includes many designs for garden buildings. But, central to attributing the building for the equatorial sector to Keene, Malchair's drawing of 23 June 1773 clearly shows this building well under construction. Sadly, this building gradually decayed and was destroyed in the 1920s. A map drawn during the 1930s (Figure 15) shows the distribution of 'garden temples' with only the site of the equatorial sector being marked at this date towards the Southwest of the park.

Writing in 1930 after the Radcliffe Trust had decided to sell the site, move the Observatory to Pretoria, and it seemed that the grounds were to be built over, in an academic article describing the history of the Observatory, Robbins (1930, 310) somewhat poetically describes the building and grounds:

> As the pilgrim passes by the little lodge of the gatekeeper he leaves behind the busy stir of the Woodstock Road and becomes, for a while all too short, one with the privileged few who dwell and labour in what might be a monastery garden. Tall trees shut out the world. A picturesque cedar, broad lawns of well-kept turf patrolled by rooks, thrushes and starlings, the observer's house, the curved passage therefrom and to the main building, with two detached obser-

> vatories, all catching the eye and produce at once a most pleasing sense of rest, quiet and refinement. PERFUGIUM MISERIS! Can it be right, can it be even expedient to permit the intrusion of any builder, however high his charges, to shut out air and light from such a scene? Gone for ever will be the beauty of form, of colour, of atmosphere intangible, indefinable, but none the less real.

The 'detached observatories' of which Robbins writes were a feature of the Observatory park from its inception.

6 THE DESIGN AND ITS PROBLEMS

Hornsby's main aim in building the Radcliffe Observatory was that it would provide space for his world-leading collection of scientific instruments from Bird and others. The building would ideally provide the best conditions for the storage of his instruments and for their display but, most importantly, provide ideal working conditions and an environment in which leading astronomers could exploit the instruments such that measurements could be made with the greatest accuracy. It was essential that the measurement instruments, with which he worked on an almost daily basis, were mounted in the best possible way on substantial pillars or walls to reduce unwanted movement to a minimum. But it was also important that the instruments should ideally be conveniently positioned for use, and that they should be accessible for select visitors to view.

Greenwich Observatory had a separate building designed for its mural instruments. This building had few architectural pretensions but was simply a single-storey building with openings to the sky. It had no heating. In the Radcliffe Observatory, physically linking the rooms in which the instruments were to be used to other rooms which had heating and considerable mass had some effects. The balanced detailed positioning of the elements of the Neo-Classical South front of the Radcliffe Observatory—the windows, slits, niches, and decorative features—also caused potential problems.

The decisions to link the two observing wings to the central tower and the use of strict Classical symmetry were not necessarily sensible ones for the accuracy of the observations that were made. Knox-Shaw et al. (1932: 58) suggest that one possible explanation for a systematic difference in some measurements was related to a diurnal change in temperature of the massive tower that was just 45 feet to the West of the transit instrument. This particular effect was not noted in 1774 when the tower had not been constructed, but was evident when the central portion was raised to two storeys, and greater still after the tower had been completed (Knox-Shaw et al., 1932: 58). The weight of the tower also necessitated adjustments. Over the years, there was a tendency for the axis of the quadrant to sink to the West—especially from 1774–1779 (Chapman, 1995b: 85; Knox-Shaw et al., 1932: 20). On 27 March 1779 once the tower has been completed in skeletal form, Hornsby wrote in his records

> Since the centre of the Building has been finished, and the Ground has received its full Weight, the Western End of the Axis has ceased to sink. (Hornsby, 1779).

The strict symmetry of each of the East and West Wings with a central door and hallway, and three internal rooms also caused Hornsby unnecessary trouble. Chapman (1995b: 83) describes the way in which four different instruments were used to develop a system of interdependent cross-checks on the accuracy of measurements—the transit, the zenith, the quadrant, and the pendulum clock. Regular checking of one against others ensured accuracy. Hutchins (2005: 70–71) describes the process of measurement undertaken at the Observatory.

> During the year, the rotation of the Earth each night, and the passage of the months, would successively bring a large number of suitable bright stars slowly "ascending" from east to west to pass across the long aperture slits in the roof above the transit instruments and the quadrants. The astronomer would have a pre-prepared list of stars that he wished to observe during the year, and to re-observe another year in order to check the accuracy of the observation, and any variations in the instrument.

For regular measurements two observing instruments were required—the transit telescope and one of the quadrants. In practice the South-facing quadrant was used more by Hornsby than the North-facing quadrant, partly because that facing North was found to be less accurate. The quadrant was used to measure the North to South latitude in the sky (called the 'angle of declination') and the transit was used to determine the exact instant when the object crossed the meridian from East to West, enabling the right ascension to be calculated (Hornsby, c. 1780). Both instruments had five vertical wires and one horizontal wire in their eyepieces.

Figure 16: The East Wing. The slits were positioned to the right of the left niche buttress and the left of the right niche buttress (photograph: Geoffrey Walford).

In other observatories such as Greenwich these measurements were made by two people in coordination each working on one of the instruments. Hornsby's original plea for funding from the Radcliffe Trust had intended that he should have an Assistant—in fact he stated that "… it is not possible that the whole can properly be done by any single person …" (Rigaud, 1820–1849: 20–21) and laid out a complicated plan where colleges would be enabled to send one student each free of tuition fees. In return the colleges would provide sufficient funds for an assistant to be employed. I have found no evidence that this scheme ever came to fruition, and it is accepted that Hornsby never had an assistant for the Observatory and that he made all his measurements by himself mostly in the daytime.

Perhaps it takes an architect to notice the details of the design of the South front. Inskip (2005: 160), who led the conservation project of the early 2000s, states that the utilitarian slots had been carefully integrated into the design by locating them adjacent to the internal angles created by the articulation of the bays at each end [on the South side]. He argues that their removal, which had occurred in a previous renovation from 1960 to 1969, disturbed the symmetry of the Wings and he hoped that the slits might be reintroduced in any future conservation project.

This detailed symmetry is shown in Figures 16 and 17, which shows the East Wing. The face of the building is far from flat and there are two levels of indentation. The two walls in which there are niches are positioned forward and placed at either end of the Wing. The two windows are placed symmetrically around the central door which is in a plane set back again from the windows forming a relieving arch for the door. The pattern of planes being set back from one another towards the centre is somewhat reminiscent or Egyptian door for the dead. Crucially, the slits designed for the instruments to see out of the building are placed in the plane of the windows at the internal angles of the between the plane of the niches and that of the windows.

Figure 17 shows the position of the stone on which the two quadrants were fixed (a). The South-facing quadrant was attached to the left of this stone (in this plan, or East). The zenith

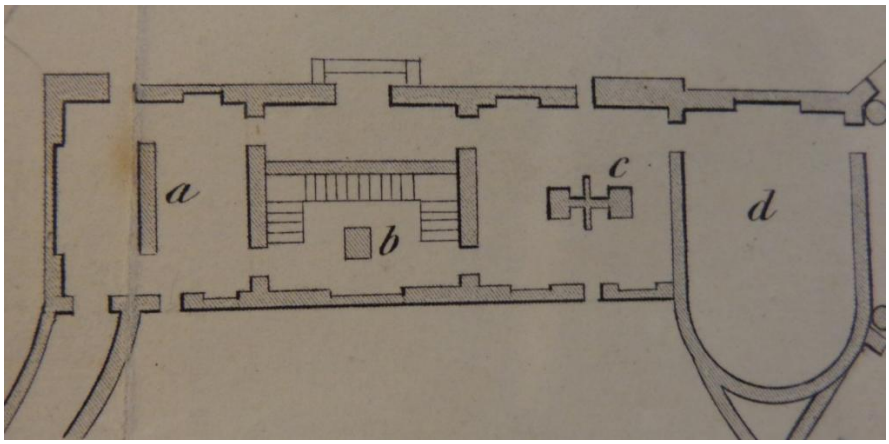

Figure 17: The East Wing, detail of Figure 10. South at top. This plan still does not show the relieving arch for the South door which provides the balance between the distances from the windows to the arch and the windows to the slits (courtesy of History of Science Museum, Oxford).

sector was positioned at (b), while the transit was fixed between two stones marked (c) at the other end of this Wing. This pivoted in a North–South direction and could be taken out of the pivots and reversed to ensure accuracy of median measurement. It is worthy of note that the North elevation of this Wing or the East Wing do not follow such strict symmetry, indicating that the South front was regarded as the main front and the North front, which faced the Observer's garden, was secondary.

Since Hornsby never had an Assistant he had to develop his own method of using both instruments simultaneously. Chapman (1995b: 86–87) states that he observed a star

> … on the first and second wires of the quadrant to obtain its declination ... then quickly transferred to the adjacent transit instrument to see it actually cross the meridian, after which he would switch back to the quadrant, to see it leave the field across the fourth and fifth wires.

As Chapman (1995b: 87) then states, "… such a technique must have demanded considerable physical agility, a flawless sense of timing and an exact memory"—even more so because the two instruments were not adjacent to one another, as every commentator states, but more than 30 feet apart through two separate doorways. I assume that the two doorways were wedged permanently open when Hornsby was observing, but he still had to perform this whole manoeuvre in less than two minutes.

At first glance, the East Wing of the Observatory could be seen as a building where 'form follows function' as it was built specifically for observations using specified instruments. Detailed observation shows that, in fact, the demand for symmetry meant that the quadrants and the transit telescope were placed not just in different rooms, but two rooms away from one other with the zenith sector room or the East Wing entrance hall between them. The desire to have a highly symmetric South front led to 'function follows form'. Even if Hornsby had been able to find money to fund an Assistant, it would have been more convenient to have had the two instruments either side-by-side, or in adjacent rooms. From the point of view of the observations, a separate small single-storey room would have been potentially more supportive of accurate measurements than the East Wing.

7 CONCLUDING REMARKS

Seeing the Radcliffe Observatory as Keene following the plan of a country house is not simply a matter of attribution and achievement. It solves a number of problems in trying to explain why the Observatory was built as it was. Hornsby's interests were mainly in increasing the accuracy of astronomical measurement. He desired to procure the best telescopes and other scientific instrument available, and have them well housed. For his convenience, he also asked for a house for his family and himself and a lecture room so that he would not have to go into the city centre to teach. He had little need for an unheated entrance hall, a highly Neo-Classically-decorated room for occasional observations, or for the four decorated barrel vaulted fine rooms with apses and fireplaces on the ground and first floors. Neither did he need the exterior decoration of eleven decorative stone signs of the zodiac, eight *in situ* carvings of the personified winds, three morning, noon, and evening panels, or the statue of Atlas and Herakles supporting a globe at the top of the

tower (Popkin, 2005). We know little about Hornsby's views on any of these ornaments (although we do know he took an active interest in some aspects of the decoration, see Walford 2025), but they played no part in his astronomical work.

Indeed, while Hornsby took regular measurements from 1773 onwards in the East Wing, he did so within what was a wider intermittent building site for the first 25 years. It was the 1790s before the Lecture Room and the Observing Room were completed and useable, and as late as 1797 Wyatt was asked to provide such vital items as ladders, eye-stands, steps, chairs for the lecture room, and tables and chairs for the side rooms. By 1805 Hornsby was too ill to continue observations, and he died in 1810. He thus had only a few years when he was able to use the completed Observatory as he might have wished.

But the Radcliffe Trustees during the building period, under the control of two successive Chancellors of the University, and influenced by Neo-Classical fashion propagated by James Wyatt and others, were building more than a simple Observatory. They wished to memorialise Radcliffe and themselves and provide a place for 'pomp and show' for them to use when required. This was initially provided by Keene's ambitious design which gathered together the various requirements for the building—teaching, research, display, entertainment, and accommodation—within a coherent and then currently popular design for a country house, and which then was over a long period sumptuously and expensively decorated by Wyatt.

In Keene's desire to produce a classical building with multiple symmetries, some of the practical requirements for observation and measurement were overshadowed by the desire to memorialise Radcliffe and the Trustees, impress visitors, and provide pomp and show. While, when some of Hornsby's measurements were finally published in 1932 (Knox-Shaw et al., 1932) they were found to be of high accuracy, the building itself potentially impeded accuracy and a different design would have made the observation and measurement process significantly easier—with or without an Assistant. There is little doubt about the Radcliffe Observatory's beauty architecturally, but its fitness in terms of providing the best working space for the instruments and observer must be in doubt.

Even though the Radcliffe Observatory was planned to be best observatory in Europe and Hornsby certainly managed to have built state-of-the-art instruments in the early 1770s, the tower design with tall windows and country house plan was not repeated. By the time the Observatory was completed in the late 1790s the nature of astronomy had changed—larger glass blanks and better lenses meant that long-focus refracting telescopes and tall windows were no longer needed, while better equatorial mountings enabled work beyond the meridian to be more easily conducted, and there was greater international acceptance and rewards for a wider range of astronomical work beyond meridian measurements. As Chapman (2000: 181) explains, the Radcliffe Observatory was "… the last major observatory to use quadrants for the measurement of declination". If the Observatory had been designed 20 years later, a dome would probably have been its central feature and there would have been no zenith sector or quadrants.

8 NOTES

1. I have used Imperial units as all documents referred to use this measure.
2. The Keene drawings were part of a larger purchase from F.R. Meatyard (difficult to decipher in the register) by the Victoria and Albert Museum (MB/21/E836-921), around June 1921, some of which were bought by him at an auction at Sotheby's. They were attributed to Keene between 1954 and 1964. Information from Alice Power, Assistant Curator Architecture and Urbanism, Victoria and Albert Museum. See: https://collections.vam.ac.uk/search/?q=henry+keene.
3. The Royal Astronomical Society holds nearly 200 letters written by Hornsby to Marlborough between 1780 and 1799.

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