The Great Observatory at Downside 1859–67

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Had it not been for an unattended heating furnace and an unexpected wind, the history of English astronomy in the late 19th century might have been quite different. As it was, these two chance events combined to cause a fire which destroyed an observatory housing what was at the time one of the largest refracting telescopes in the world. The fact that both the telescope and the observatory are now almost entirely forgotten is probably due to their seemingly unlikely location – the grounds of Downside Abbey, a Benedictine monastery between Bath and Wells in Somerset. This paper seeks to rescue the Great Observatory from obscurity by detailing the reasons why it was built at Downside in the first place; its design and construction; its brief operational life; and finally its sad demise. A few speculations are then entered into regarding what the observatory might have achieved had it survived.

1. A little background

To understand why Downside Abbey was not, in fact, as unlikely a location for a major astronomical observatory as might be thought it is necessary to go back several centuries, assisted by information gleaned from a very full history of the Abbey and school, *Downside*, written by the Benedictine monk and historian Henry Norbert Birt (1861–1919).[1]

Late in the 16th century, the reforming zeal of Elizabeth I meant that Catholic priests who continued their training and ministry in England risked capture, torture, and death. Schools were thus established on the near-continent where priests could be trained in safety to fill up the rapidly dwindling ranks of the old clergy. These schools were often located in religious houses, widely separated from one another, and so a desire arose to found a new centre into which these scattered communities could be gathered.

1.1. *St Gregory's College is established*

In the case of the Benedictine Order this was finally achieved in 1606 when a monastery dedicated to St Gregory was founded in the French town of Douai, into which they moved in 1611. Douai was chosen because of its pre-existing English College of the secular clergy and also because it was a university town already popular with English recusants. Other houses were established in Dieulouard, Lorraine; St Malo, Brittany; and Paris.

It was not only priests who suffered as a result of the Reformation, as it became almost impossible for Catholic children to obtain a decent education in England. Those families who could afford it were able to send their children to the continental English schools which, although they had originally been established for the training of priests, were now being opened up to lay persons also.

It was natural for the tutors at these schools to be drawn from the religious community, not just for theological reasons but also because monks were themselves among the best-educated people around at the time. The Benedictine Order in particular was at the forefront of this development, as it had a long tradition of service to the community and a flexibility of organization which enabled it to restructure itself to meet changing needs.

As soon as the English monks were solidly established in Douai, their reputation for learning was recognized and they were called upon to provide professors of philosophy for Marchienne College in that town, and to occupy Chairs in the University. English parents naturally desired to entrust their sons (for it would only have been the sons in those days) to the training of the English monks and so there was a ready demand for their services.

Beginning very soon after the foundation of Douai, and firmly established by 1625, a predominantly lay school thus developed. This continued to prosper during the 17th and 18th centuries, expanding its buildings and number of students, but everything was brought to a crashing halt by the upheaval of the French Revolution in the late 1780s.

1.2. *Return to England and the move to Downside*

Many English students managed to escape back to their home country before the fortunes of war swung against the Revolutionary forces, who were forced to fall back to a defensive position in Douai town. This resulted in the community being forcibly evacuated in dreadful circumstances, after which the church and other buildings were ransacked and plundered to such an extent that after their eventual release from virtual captivity it was impossible for the monks to return to their former activities. Given also the considerable antagonism for the English which had developed after the Revolutionary Wars, it was clear that Douai could no longer be relied upon to afford a home.

Fortunately, the religious climate in England was now very much more tolerant than it had been two centuries earlier, and so permission was sought for both the monks and the lay people still with them to escape the disturbed state of France by travelling across the Channel. After a number of refusals, permission was finally granted early in 1792 when 92 individuals drawn from several religious communities in Douai and St Omer bade farewell to France, crossed the Channel in an American vessel, and made landfall at Dover on March 2.

The deprivations of captivity had reduced the numbers at St Gregory's to such an extent that barely a dozen were left by the time of the return to England. They were initially supported by Sir Edward Smythe (1758–1811), a former pupil, at his family seat of Acton Burnell in Shropshire, where he put aside a portion of the park (and later a wing of his house) so that a school for boys might be opened. This grew slowly, and a chapel was added, but a combination of financial constraints and hopes of an eventual return to Douai hampered its development.

Fate intervened again in 1811 however, when Sir Edward died. His son required all the accommodation at Acton Burnell for his young family and the dowager Lady Smythe, and so another move became necessary. After considering a number of locations, an area of land close to the city of Bath was purchased. Hence in 1814 a new Benedictine house was established at Downside, together with a school whose reputation for educational excellence dated back many decades.

2. Later developments

All thoughts of a return to Douai eventually faded and the buildings at Downside, both religious and secular, were steadily added to over the next forty years. A serious downturn in fortunes in the 1830s caused by the opening in nearby Bath of Prior Park College, a competitor Catholic school offering a new and modern curriculum, was soon overcome so that by mid-century both the monastic community and the school were well established.

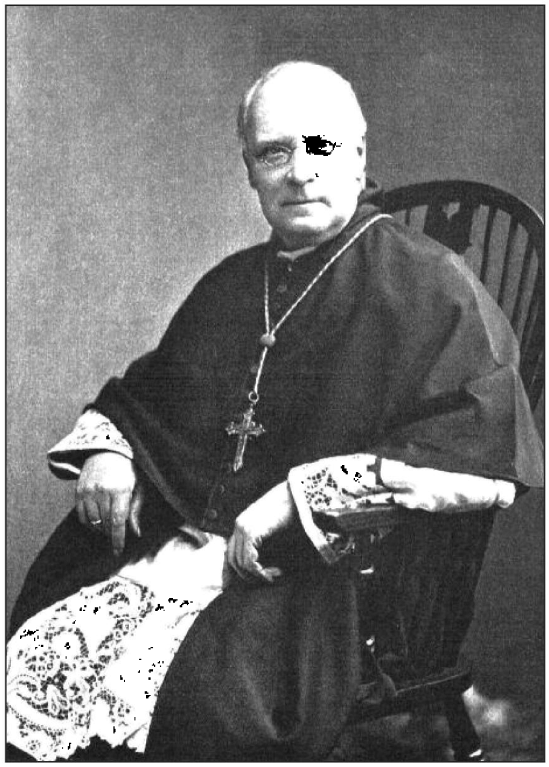


Fig. 1: Dom Benedict Snow. Educated at Downside from 1851–55 and ordained in 1865, he was librarian from 1866–68 and also curator of the observatory before leaving to become a parish priest. Snow was made Provincial of York and titular Abbot of Glastonbury in 1888 and died at East Dulwich. © Downside Abbey Archives.

Indeed, in 1854 Downside opened a major extension to its school, designed by the well-known Catholic architect Charles Francis Hansom (1817–88) of Clifton, Bristol. A comprehensive syllabus was now being taught, including modern and ancient languages, history, geography, mathematics, religion and, importantly for later developments, science.

This latter subject evidently included some aspects of astronomy. Terence Benedict Snow (1838–1905), curator of the short-lived observatory and later to become titular Abbot of Glastonbury, records in his 1903 book *Sketches of Old Downside* that 'Star-gazing at Downside has had its fluctuations. The Great Bear, the Polar Star, Orion's Belt, at times attracted flattering attentions, at others they twinkled on neglected and unnoticed; an erratic comet with its appendages would revive flagging interest, or Saturn's ring, or Jupiter's moons, or Venus chasing the setting sun over Cox's shrubberies. On these occasions a brass telescope was brought out, secured on a small table, and surrounded by a knot of boys awaiting their turn'.[2]

2.1. *Early astronomical interest*

How or why this fascination with astronomy was being fostered is unclear. The Benedictine writer Hubert van Zeller (1905–84), who resided at Downside Abbey, tells us in his 1954 book *Downside By and Large* that during the academic revival of the 1840s 'ornamental science' was added to the curriculum.[3] The development of this subject was strongly encouraged by contacts with London University, while the Great Exhibition of 1851, where large telescopes were displayed and the first national weather forecasts were posted, spurred a wider interest in all things scientific, particularly astronomy and meteorology. Abbot Snow tells us that at Downside, 'The complete set of meteorological instruments, the records of which were sent to Greenwich, furnished another instruction to scientific knowledge'.[4] The 1854 extension added a chemical laboratory and study-room, and students were being taught in the quaintly named philosophical-instrument room.[5]

Whatever the reason, the next development was a major one because as early as 1854 news arrived at Downside of the purchase in London of a 15-inch (0.38-m) object-glass, one of the largest in the world at the time. This rumour was later confirmed by the news that 'a building worthy of the glass' was in contemplation.[6]

Many aspects of the project raise puzzling questions, and these have been only partially resolved through recent research in the Downside archives. In particular, despite the fact that money must have been in short supply after the recent building extensions, here we have the community not only purchasing (Snow's word) perhaps the largest telescope in England but then apparently commissioning the same Charles Hansom who had been involved with the building extension to design a substantial observatory, transit room, library, and museum – the whole exceeding 2000 square feet (186 square metres) on two floor levels – generously appointed and decorated and with no obvious attempt at economy.

The only substantive clue arises from an entry in the archives which reveal that the (Latin) minutes of a Prior's Council meeting dated *Tertio Idus Iulii MDCCCLIX* [1859 July 13] record permission for the expenditure on the building of an observatory of *circiter £600* from the *peculium* [endowment] of Dom Benet Tidmarsh (1818–1902) who, being a councillor himself, had presumably presented the proposal.[7] In fact he had been cellarer (i.e. bursar) until 1854 and hence must already have worked with Hansom on the earlier building. It could be, therefore, that Norbert Birt was referring to Tidmarsh when he alludes to 'an enthusiast in astronomical research' in his description of the observatory.[8]

2.2. *Competition spurs determination*

Whether just the strong support of one individual, however influential, would have been enough to force through this expensive project is open to question. A critical factor that might have swung the argument is one that is well-known today – competition. The negative effect of another school opening nearby has already been mentioned, and there was more generally a lively rivalry between the various Catholic boarding schools and competition for pupils, especially from the leading Catholic families on whose benefactions they depended.

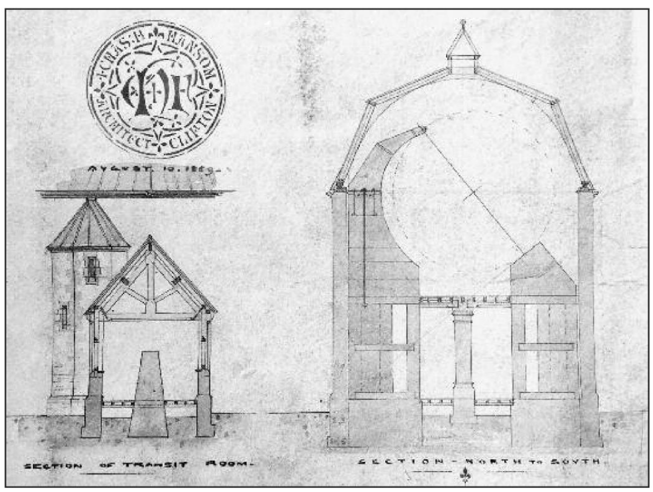
The Downside observatory might thus have been seen as a prestige project designed not only to attract more scholars to the school but also to support the independent academic life of the monastery itself. This had become increasingly important for many houses during the 19th century, when Catholics did not have access to English universities, and had developed entirely separately from the secondary schools attached to them.

An observatory would be particularly attractive as it would build upon the interests seemingly already active in the community. It would also be indicative of a scientific, and thus modern, outlook and serve as a counter to those facilities being set up by the Jesuit community who, historically, had an even greater interest in education and, latterly, science than the Benedictines. Indeed, the observatory they established at Stonyhurst College, Lancashire, in the late 1830s may well have provided a model for Downside.

The eminent Italian astronomer Angelo Secchi (1818–78), of the Jesuit Collegio di Romano Observatory in Rome, had stayed at Stonyhurst in 1848, in retreat from revolutionary troubles in Italy, and Stonyhurst's astronomical leanings, particularly in solar observation, apparently stemmed from his time there.[9] Around this time the Stonyhurst Observatory had acquired a 4-inch (100-mm) refractor, which was then upgraded to an 8-inch (200-mm) in 1867, and again to a 15-inch (380-mm) by Grubb in 1894.[10]

It is also recorded that 'throughout the 19th century improvements were being made to the buildings … The Stonyhurst Observatory was particularly well equipped

Fig. 2: Charles Hansom's final design for the Downside Observatory shows a north–south cross-section of the transit and equatorial rooms, with the astronomical library beneath. It bears the architect's stamp and is dated August 10 1859. © Downside Abbey Archives.



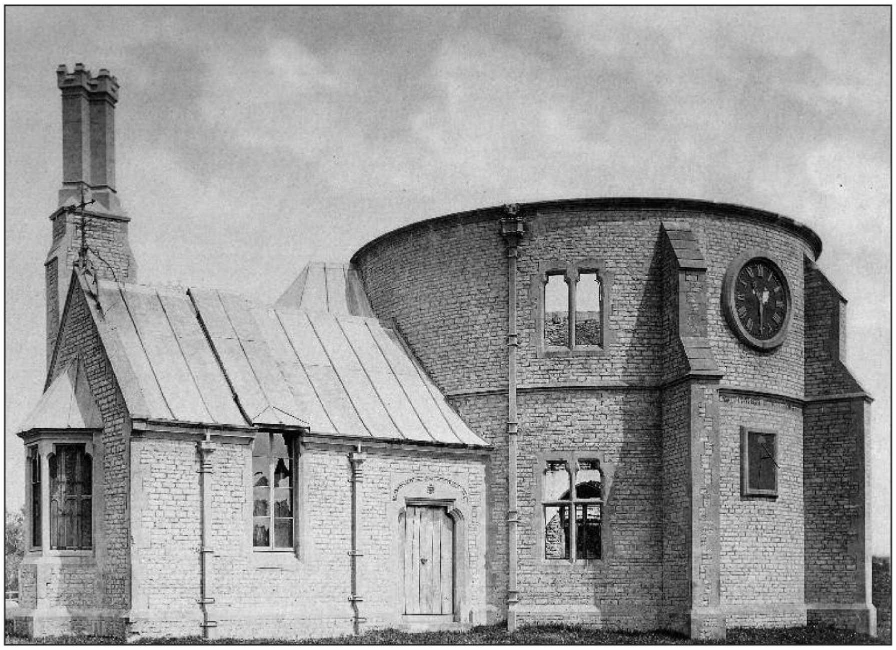


Fig. 3: The gutted shell of the Observatory building as it appeared in 1871, possibly taken by Monsignor Lord William Joseph Petre (1847–93), who was educated at Stonyhurst and Downside. He taught at Downside from 1874–77, where he endowed a library in 1876, a cloister, and a swimming pool. © Downside Abbey Archives.

and between 1865–83 functioned as one of the Board of Trade's meteorological stations'.[11] These developments would not have passed unnoticed at Downside, possibly providing the extra impetus for the development of its own observatory.

However it was instituted, the dream of Downside becoming (to quote Snow) 'a centre of astronomical life' with 'visions of astronomical triumphs … and a halo of scientific glory'[12] was taken seriously, as is shown by the two sets of attractive coloured plans from the office of Charles Hansom, still in the Downside archives (Fig. 2).

Proof that this ambitious scheme was in fact executed is evidenced not only by Snow's narrative but also by a fine photograph of the fire-gutted, but otherwise upstanding, shell of this great observatory (Fig. 3). Nevertheless, the fact that the date of the architect's plans was some five years later than the news of the purchase of the object-glass does lead one to speculate what schemes, if any, might have developed in the meantime.

3. The 'Master Builder' arrives

While Hansom was the architect for the project, the site manager and, it would seem, designer of the scientific equipment within the Observatory was one 'Mr. Slater of London', from whom the object-glass had been purchased; we shall have more to say about him later. His arrival on site was clearly a dramatic event, for Snow tells us that

> In due course Mr. Slater, the maker of the glass, appeared, a short, square-built man, clad in a rusty black frock-coat, with an iron-grey grisly beard, florid cheeks, wandering eye and iron-grey hair encased in a black velvet smoking-cap. He was regarded with the deference paid to a magician with weird powers, especially on hearing that he had traversed the hilly road from Bath on a tricycle made by himself, and worked by a small steam-engine under the seat, at a cost of threepennyworth of spirits of wine for the journey. This combination of genius and economy fully established, in our youthful minds, his competency for any scientific undertaking.[13]

Spirits of wine is what would now be called methylated spirit, but whether Mr Slater actually had a meths-powered three-wheeler at this early, but not impossible, date is not entirely clear. Snow maintains the mystical tone of Slater's arrival in his next passage:

> On a bright playday the magician came, with an attendant spirit carrying a tripod, which when extended and erected supported, not a cauldron, but a theodolite. We thronged round the unwonted sight, and were warned to keep a respectful distance, from no danger to ourselves but rather to the instrument.
>
> The tripod flitted from place to place, mysterious wands were planted here and there, cabalistic characters were marked on the turf, and when the magician vanished we felt that the scientific era had really commenced.[14]

While the flowery phraseology is clearly deliberately overstated, it does capture something of the wonder attached to scientific endeavours in this era. Recall that Faraday's experiments with electromagnetism had been performed just 20 years before, and that chemistry was still imbued with more than a whiff of alchemy in the mind of the general public.

4. The Observatory building

Hansom's revised plan, bearing the date August 10 1859, simplified the earlier plan for a transit room but, if anything, elaborated the planned equatorial room, which was to be the principal workspace. The photograph of the shell, dated 1871, confirms the execution of this plan in every visible detail (Fig. 3).

A fine building, very much in Hansom's idiom, the Great Observatory was perched on the highest point of Mogg Hill and must have made a striking impression on those who ventured thus far from the main school and monastery (Fig. 4). Snow, though, was unimpressed:

> The building was not artistic; it was a temple of science, not of art. Even on a bright day, with the blue sky and a belt of dark trees behind, the picture did not satisfy the eye. A circular wall of white lias, thirty feet in diameter and thirty feet high, with buttresses and semi-Gothic windows surmounted by a large, glistening zinc dome of no approved shape, crowned by a cap in no known architectural fashion, was not a pleasing object … A small rectangular transit-room jutting up against it on the west destroyed its symmetry, and suggested a scientific washhouse.[15]

There speaks an architectural snob, one feels. To top everything off, both literally and descriptively, Snow tells us about the observatory roof:

> To gain access to every part of the heavens required ingenuity in the construction of the large, heavy roof. On the top of the wall and round the ninety feet of its circumference rested a thick iron plate, containing a large groove; at the bottom of the roof was a similar groove in a thick iron casting, furnished on the inner side with upwards of a thousand teeth; between the two grooves were placed cannon-balls, on which the roof rested and revolved. At intervals in the side of the wall were fixed capstan-looking wheels that worked rods with cogs fitting into the teeth of the roof plate, and on turning a capstan the roof slowly revolved; a couple of shutters turned back on hinges and left an open slit of six feet.[16]

Fig. 4: Pen-and-ink sketch of Downside Abbey and grounds from the archive collection of Dom Alphonsus Morrall (1825–1911), Prior of Downside 1866–68. The observatory building is shown at upper centre. The plan is undated, but is thought to have been drawn up in 1866, the year before the observatory was destroyed.
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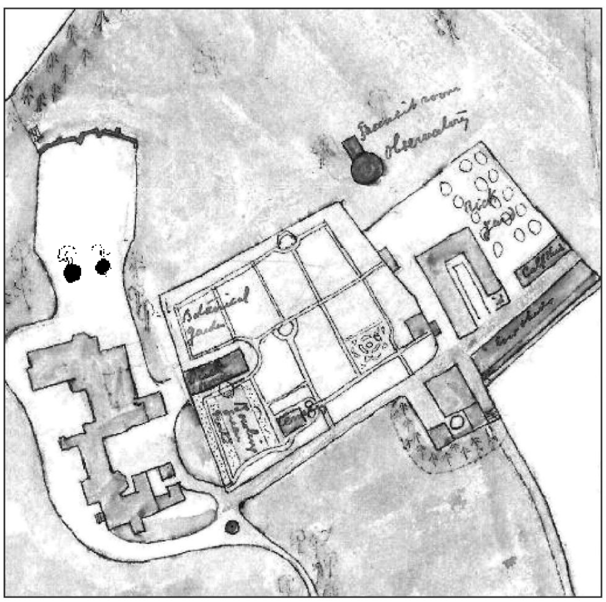

Cannon-balls were readily available in the mid-to-late 19th century, as artillery began to change over from ball to shell ammunition and also as surplus from conflicts such as the Crimean War and the American Civil War, and so the use of these mass-produced but accurately made spheres as bearings for observatory roofs was very common. In all other respects, the mechanism for causing the dome of the roof to revolve which Snow describes is almost exactly the same as in more modern large observatories.

4.1. *The equatorial and transit rooms, and the museum*

If the outside aspect was not to Snow's liking, he at least conceded that the inside was appropriate to its function:

> The interior was arranged solely with a view to scientific work. The circular building was divided into two compartments, the lower of which, some fifteen feet in height, was necessary in order to raise the telescope. The upper, the equatorial-room, reached by a spiral stone staircase, formed a spacious hall of noble dimensions, thirty feet in diameter, the walls fifteen feet high, and the apex of the dome some forty feet from the floor.[17]

Snow gives us an equally precise description of the transit room:

> In comparison with the equatorial, the transit room jutting out below was quite modest in size and appointments. Rectangular in form, it had casement windows in the north and south walls and a sloping zinc roof with two shutters. When these were drawn back, and the windows opened, it left a clear space from sill to sill six feet in breadth. The telescope, four and a half inches in diameter, rested on two small piers, and had an accurately fixed motion due north and south to catch the stars in the middle of their course and mark the time of the passage of the meridian. A transit-circle, clock, and the usual instruments completed the furniture.[18]

That last reference to the clock is of particular interest since it refers to the salvaged regulator timepiece still operative in the monastery. Having escaped the ravages of the fire, it was reconstructed some time in the early 1890s by Father Edward Stutter (1842–1922), a keen amateur astronomer, and taken by him to Acton

Burnell, where the Benedictines had initially been located after their flight from France and still had a presence. It there actuated the chronograph in the small observatory he had built, containing a 150-mm equatorial and a 75-mm transit instrument.[19] After Father Stutter's death the timepiece was stored for many years in a box at Downside until, in the late 1950s, it was restored by Dom Augustine James (1883–1970).

In the space below the equatorial room was found a home for the College Museum. We are told that 'Glass cases lined the walls and stood in the centre of the floor, and in these were stored fifty years' accumulation of collections and curios. Every phase of museum acquisitiveness was more or less represented … The whole was in good order, and formed the nucleus of a capital museum'.[20] The decision to display these items in such close proximity to the telescope would, as we shall see, have dire consequences some years later.

5. The object-glass

Before moving on to describe the construction of the telescope itself, it is appropriate to consider the wondrous object-glass. As mentioned above, both van Zeller and Snow tell us that it was obtained from a Mr Slater of London but give no further details. It is virtually certain, however, that this was Thomas Slater (1817–89), one of the most ambitious optical technicians of the 1840s and with a fairly high opinion of his own talents.[21]

He was certainly eager to experiment with the possibility of producing very large object-glasses, and is perhaps best known for the largely unsuccessful 24-inch (0.61-m) Craig telescope erected on Wandsworth Common in 1852 but disused by 1854 and dismantled just two years later.[22] A very comprehensive account of all aspects of the history of this telescope may be found at the website *The Craig Telescope, The Story of London's Lost Leviathan*.[23] On the page devoted to Thomas Slater it is stated that 'At his address in London [Somers Place, Euston] he had workshops and even a well equipped observatory housing his own skilfully made 14.78-inch (37.54-cm) aperture refractor through which he was to observe Donati's Comet [in 1858]'.[24]

It would seem that the object-glass of Slater's own telescope was the twin of the one he had supplied to Downside. But how did he come to be in possession of such a large refractor? In his account of the Downside lens Norbert Birt describes it as 'a wonderful telescopic object-glass, the "sister" of which was secured for the Government Observatory at Cape Town'.[25]

However, a search of the website of the Royal Observatory, Cape of Good Hope, the formal name of the 'Government Observatory' and now part of the South African Astronomical Observatory, yielded no mention of a telescope or lens of 15 inches aperture.[26] An inquiry to the SAAO confirmed that no such lens was in their possession at this early date – indeed, they had no telescope larger than 7 inches (0.18 m) until around the 1890s.[27]

Whether Birt's suggestion is something of a myth, or whether the Royal Observatory had got wind of the failure of the Craig telescope and thus cancelled their order, we may never know. All that can be said is that a 15-inch refractor would be a very large instrument to be in the hands of an amateur observer in the 1850s and so the possibility that its lens was originally made for some other purpose is quite strong.

5.1. *Comparison with other large refractors*

Which brings us to the other statement made about the object-glass, namely that it was 'one of the largest in the world'. A list of the largest telescopes of the 19th century in Wikipedia tells us that there was no refractor of greater than 10 inches (0.25 m) aperture until 1843 and that apart from the Craig telescope there were only two examples of 15 inches or greater right up until the 1870s and 80s.[28]

The earlier of these two, the 15-inch refractor at Harvard College Observatory, was the largest in the USA from 1847 until the 18.5-inch (0.47-m) at the Dearborn Observatory, Chicago, took its crown in 1865, becoming the largest in the world in the process. This list is not quite complete as it stands though, as the Pulkovo Observatory in St Petersburg, Russia, had a 15-inch refractor in 1839, whose lens was the twin of that at Harvard. Also missing is the 13.5-inch (0.34-m) Grubb refractor constructed at Markree Observatory, Ireland, in 1834.

The Pulkovo, Harvard, and Markree instruments, and several of those in the Wikipedia list, are mentioned in Henry C. King's book *The History of the Telescope*[29] but no reference includes the Downside instrument, or that used personally by Thomas Slater, so there could be other omissions. However, it does seem reasonable to conclude that the Downside refractor was indeed one of the largest in the world at the time of its construction, and (again excluding the Craig telescope) certainly larger than any which would be constructed in the UK and Europe until the 1880s.

We are told by Abbot Snow that the object-glass 'comprised two plane convex lenses riveted together'.[30] van Zeller says 'welded', so it must be assumed that they are both referring to some sort of support frame rather than the lenses themselves. This form of construction is entirely plausible, being similar to that used for the Craig telescope.[31]

It is noted that 'Sir James South, Mr. Delarue, and other astronomers of note had examined it, and pronounced it to be an excellent glass'.[32] Sir James South (1785–1867) was a founder and later President of the Astronomical Society, and a noted amateur observer in the 1820s and 30s.[33] Warren De La Rue (1815–89) was a pioneer of astrophotography of the Moon and Sun, and also produced one of the world's first electric light bulbs.[34] The approval of these great men undoubtedly helped Slater's reputation.

6. The telescope and its mount

While the description of the telescope itself given by Abbot Snow is somewhat sketchy, he does provide a very comprehensive description of its mount:

> A massive pier on the north rose up through the floor from the rock below to a height of fifty feet from the ground, and was surmounted by an iron girder which, like a giant hand, clutched a huge beam that rested diagonally on a similar smaller pier on the south; to prevent vibration, these piers were built free from the wall and floor, and stood solid and independent. Attached to the beam was a large iron cradle, on which rocked or slept the tube of the telescope. With a focal length of twenty feet and a diameter of eighteen inches, the huge wooden tube looked unmanageable; but being evenly balanced by a large fly-wheel on the side of the beam opposite to the cradle, a slight touch easily set it in motion: the cradle moved on the beam and the beam itself, which formed the polar axis, revolved between the piers, thus producing the double motion, and enabled the telescope to be moved to any part of the heavens except due north.[35]

From this description we can tell that the mount was almost certainly of the English cross-axis type, in which both ends of the polar axis are supported on pillars.[36] This makes the mount very rigid, but is suitable only for a permanent installation because of its bulk and the impossibility of changing the angle of the polar axis by any significant amount, this being basically determined by the relative heights of the pillars. No image of the Downside telescope is known to exist, but its general appearance must have closely resembled George Bishop's 7-inch (180-mm) of 1836 at his observatory in Regent's Park (Fig. 5).

6.1. *Ancillary equipment*

Snow then moves on to the ancillary equipment, mentioning that 'eight Huyghenian eye-pieces, ranging from 75 to 2,000 powers, magnified to that extent the image formed in the focus of the object-glass' before describing the forerunner of the electric motor drives later attached to equatorial mounts: 'The weight-clock was an ingenious application of clock-work to put the telescope in motion at the same rate as the star, so that after it was attached there was no need of touching the tube; weights were added or taken off according as the star was hasty or sluggish in its movement.'[37]

Weight-clocks were not clocks in the horological sense of the word, as they were not intended to tell the time but merely to rotate the polar axis in order to track objects as they moved across the sky. Their central component was a drum mounted on a shaft, around which were wound multiple turns of a cord, from which hung the weight. The tendency of the drum to spin around when the weight descended under the influence of gravity was controlled by a regulator mechanism driven off a gear-wheel attached to the drum. The polar axis slow-motion control was then attached to the shaft of the drum.

Unfortunately, Abbot Snow's description of the Downside mechanism is insufficient to tell us which

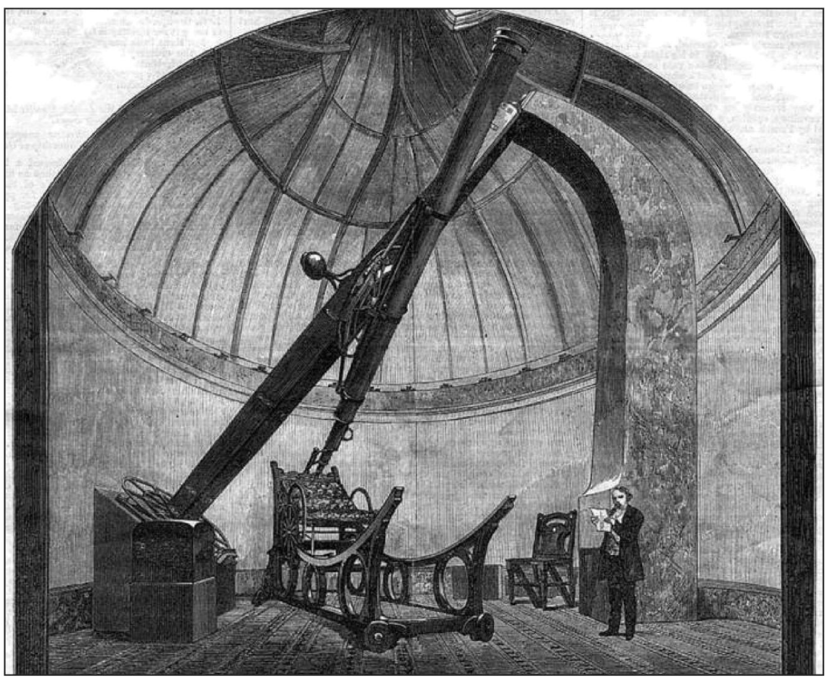

Fig. 5: The Downside telescope would probably have looked like a larger version of the 7-inch (180-mm) refractor made by George Dollond in 1836 for the private observatory of George Bishop (1785–1861). Like the Downside telescope, this was supported on an English mounting. Bishop's telescope was originally housed at the South Villa of Regent's Park, London, but is shown here in a drawing from the Illustrated London News after its move to Twickenham where it was re-erected by his son on the north bank of the river Thames.

type of regulator was used. The earliest practical drives used the constant circling motion of a conical pendulum,[38,39] before being largely superseded by those regulated by a fly-ball governor similar to those used on steam engines.[40] However, neither of these types of regulator would normally be adjusted by 'adding or removing weights' as Snow states, but rather by moving the pendulum bob or fly-balls along the arm upon which they are mounted.

Conversely, while it would be possible to use a swinging pendulum plus lever-escapement (as in a true clock), which could indeed be adjusted by adding or removing weights, there is no historical evidence in the literature or from surviving telescopes from the period that this type of regulation was ever used – mainly because the action of the escapement would tend to introduce an undesirable intermittent motion into the drive. Regulation by true clocks did find favour in the mid-20th century, but using balance-spring escapements rather than pendulums.[41]

One cannot discount the possibility that the drive on the Downside telescope was regulated by a purely frictional device and adjusted by altering the driving weight,[42] or was perhaps even one of Slater's own devising, but it is unfortunately not possible to draw any firm conclusions.

7. Using the telescope

A major problem with large telescopes (and particularly those of great length, as almost all were in the 19th century) is actually getting your eye to the eyepiece, which can be almost anywhere within the observatory dome. Snow tells us how it was done at Downside: 'To reach the telescope in every position two wooden stages, fifteen feet high, were provided within the room, and these had a double motion on iron rails – one round the room from pier to pier, the other to and fro on the framework to bring the eye to the telescope; seats were arranged in tiers and some loose cushions ministered to the comfort of the head and other members'.[43]

Making an observation was therefore not a straightforward matter. Indeed, Snow tells us that the preparation for a peep at a star was an elaborate process:

> Having secured a fine night and lit the gas, you seized a capstan and heaved away hand over hand, and slowly moved the heavy roof, creaking and grunting, until the slit was on a line with the star; a touch at a rope made the roof politely doff its cap, and a tug at two others opened the upper and lower shutters, and discovered your night's hunting-ground in the sky; you next mounted the stage and adjusted it sidewards and forwards into position, took your seat, and smoothly and easily swung round the great tube within your grasp.[44]

Opening the roof, pointing the telescope in about the right direction, and gaining your seat were, however, just the initial obstacles to be overcome before you could actually see anything. Snow continues:

> Surrounding the eye-piece was a bewildering array of appliances worthy of a high-pressure steam-engine; one handle moved a ten-feet lever that clamped the telescope at the centre, another similar one gave it a slow motion, a third attached it to the weight-clock. Near these were the focussing apparatus, the circles for declination and right ascension with their verniers, a gas-jet to illuminate the verniers and micrometer wires, and, lastly, a little baby telescope called the "finder".
>
> Having coaxed the infant to find your star, you clamped the whole concern, attached the weight-clock, adjusted the focus, became satisfied that all the instrumental trappings were in order, and calmly composed your eye for whatever intelligence the star had to convey, the celestial colloquy being suspended now and again to heave away at a capstan to keep the roof-opening in proper relations with the telescope.[45]

8. Observations at Downside

Although the Great Observatory was successfully completed in early 1860, all was not well. Hubert van Zeller tells us bluntly: 'Admitted by the astronomical world as being one of the finest in the country, the Downside Observatory possessed this one defect: it did not work.'[46]

Abbot Snow confirms this assessment: 'Apart from the meteorological observations, the scientific work of the observatory never assumed any definite form, mainly on account of the imperfect adjustment of the object-glass. After fixing all the machinery, minute, careful, and patient observations with delicate manipulation were necessary in order to adjust the position of the two lenses so as to give clear definition to the celestial objects.'[47]

van Zeller continues: 'Mr. Slater was sent for, and reluctantly came. Swiftly and dexterously he adjusted the instrument for a view of nearer objects (the moon and so on) and then, very hurriedly, went away again. This was repeated several times: Mr. Slater bouncing rhythmically up the drive on his steam tricycle, adjusting the gauge of his telescope to ever nearer and nearer ranges, instructing the students to wait patiently for a break in the clouds, and off again over the hills before dawn.'[48]

8.1. *Early hopes unrealized*

The authorities delicately hinted that Slater had lost interest in the project as soon as he had received payment. He retorted that he was 'at any time at their service if the authorities would only sweep the sky of its clouds, for which he did not supply a scientific broom'.[49] The correspondence threatened to become strained, with Slater only rarely responding to appeals to attend to his creation and then giving up altogether. As van Zeller put it: 'The tassel on his velvet cap no longer rose and fell in those automotive rides along the lanes of Somerset.' [50]

It should not be thought, however, that the telescope was a total failure. It simply fell short of the level of perfection that had been expected of it, thereby demoting it to an 'educational' instrument rather than one capable of serious astronomical use. Abbot Snow gives us a vivid account of observations made of the Moon and planets:

> On a warm, clear night the instrument had a fascination of its own … The nearer moon and planets created more enchantment, especially the jagged edges of the crescent moon … the light from the earth dimly outlined the mountains and valleys in the shade … At other times a bright speck would appear at some distance from one of the [crescent] horns; it was a mountain peak at sunrise … Saturn was a beautiful object … Jupiter and its moons in a frequent state of occultation, Mars and Venus shone on the field with great brilliancy.[51]

Observations were also made of the Sun using (possibly unwisely) 'a series of darkened glasses adjusted to its brightness' and, more surprisingly, 'an ingenious eyepiece invented by Mr. Dawes'.[52] A Dawes eyepiece is not the sort of item one would expect an amateur observatory to possess. Made by the eminent makers Thomas Cooke & Son of York, such an eyepiece is a rather large cylindrical affair approximately 75 mm in diameter which can be focused independently of the telescope with its own rack-and-pinion mechanism.[53]

Unwanted heat is absorbed first by a ring of solid ivory, and afterwards by a disk of ceramic material with a central perforation. The Sun's light then reaches an aperture wheel which contains ten bored holes ranging from 9/32 to 1/130 of an inch (7 mm to 0.2 mm); these serve to restrict the field of view. A second wheel is placed behind the first and this holds six single lenses of increasing power. A third and final wheel holds seven 'London Smoke' glasses of varying intensity that reduce the brightness of the image. This eyepiece thus conveniently serves three functions: alteration of field diameter, magnification, and absorption or dispersion of unwanted heat and light.

8.2. *A remarkable observation*

Snow then again shows his delight in whimsy by telling us that

> The only discovery on record made with the telescope excited considerable local interest. A stout astronomical aspirant for the first time fixed his attention on the jagged edge of the moon; after gazing intently for some moments he declared that he saw "biffins" in the moon. "Biffins" was a local name appropriated to dried Normandy pippins floating in a luscious fluid, a dish that graced the College board at its superior festivities; a fancied resemblance between these and the craters on the moon led to the discovery, which speedily spread through the whole establishment.[54]

Whether this startling discovery was reported in the learned journals of the time is not recorded.

9. The demise

Snow begins his description of the ultimate fate of the Great Observatory by saying: 'The expectations of scientific work, or of credit to the College from the possession of such a magnificent instrument, were doomed to disappointment, for the whole structure was reduced to ruins in a few hours.' [55] He then relishes every detail of the disaster which took place on the morning of Sunday 1867 January 20, first setting the scene:

> The building was warmed by hot air; a furnace sunk outside the east end of the observatory heated a flue under the floors of the museum and transit-room, iron gratings admitting the hot air into the building. One frosty night the attendant, finding the fire dull, left the dampers open; a fresh east wind sprang up during the night, and the furnace, being taxed to its utmost capacity, overheated the cement lining of the flue and set fire to the joists of the floor.[56]

Matters then progressed very rapidly:

> On that Sunday morning the meteorological observations were taken at nine o'clock, and nothing amiss was noticed; at ten o'clock the alarm was given of fire in the museum. On arriving at the spot it became evident that the building was doomed, for it was impossible to enter the museum or the equatorial-room … The flames first burst through the windows, crackling and angry at being confined, and as they licked up the roof and found vent the molten zinc trickled down the eaves. Before long the supports of the roof were eaten away, and then came the great crash, the lull, and the roar of the conquering flames soaring up jubilant. By the end of high mass all that was consumable had perished, and the fire smouldered on among the debris till late in the afternoon … The large object-glass was found in the debris, shattered into fragments, some of which showed evident signs of fusion.[57]

Although the local fire-brigade were called, their efforts were in vain:

> Without loss of time the fire-engine was hauled to the spot, but the hose when screwed together proved to be too short by some yards to reach the nearest pond. The men at once rolled a large tub on to the scene, broke the ice (a foot thick), and carried the water in buckets to the tub into which the hose was inserted … It was bitterly cold, with a dull leaden sky and a strong wind … the clothes of the amateur firemen were covered with ice, and some thoughtful soul provided hot beer for the men who worked at the engine and the buckets.[58]

9.1. *A disaster waiting to happen*

With the exact knowledge provided by hindsight, Abbot Snow added a final comment: 'If the contents of the building had been designedly arranged to accelerate a fire, it could not have been better prepared: the light dry wood of the museum cases and the stuffed birds quickly spread the flames, which, eating rapidly through the floor of the equatorial-room, caught the light framework of the wooden stages, which took them direct to the roof.' [59] No risk assessments in those days, unfortunately.

Reports of the fire are very few and far between. Indeed, apart from the local records, only one was found, in the snappily titled *County Observer and Monmouth Central Advertiser* (also syndicated to the *Abergavenney and Raglan Herald*, the *Usk and Pontypool Messenger*, and the *Chepstow Argus*). In a section headed Epitome of News, among articles relating to 'The Trafalgar-square Lions' and 'Death from the Bite of a Centipede', we are told that

> On Sunday the observatory connected with St. Gregory's College, Downside, near Bath, was totally destroyed by fire. It originated apparently in the heating apparatus, which kindled the joists of the ground floor; the flames, which caught some stuffed birds and other natural history specimens in the museum kept in the lower room, were rapidly communicated to the equatorial room above, in which was a magnificent refracting telescope of 15 inches diameter and 20 feet focal length.
>
> The observing stages formed capital fuel for the fire, and in less than an hour the whole was one mass of flame, leaving no possibility of rescuing anything. The loss of the glass and astronomical plant attached to the telescope is the more unfortunate, as the observatory had only just been placed in full working order. The loss to the college of the antiquities, curiosities, and natural history collections in the museum cannot be estimated, for they contained many unique and invaluable specimens and were the result of 50 years' accumulation. [60]

Thus perished the observatory and its contents; its subsequent fate was ignominious. The north support pier survived the flames with, in Abbot Snow's words, 'its iron girder like a giant spectre-finger held up in warning', but the danger that it might fall meant it was soon removed.

While the relatively undamaged transit room remained in service for many years as a Clerk of Works office for the early phases of the building of the nearby abbey church, the shell of the main structure was demolished and its stone cannibalized for use in current building projects. Ironically, the semi-gothic windows of one of these bore a striking resemblance to those of Charles Hansom's observatory.

Summing up the situation in his 1903 book *Sketches of Old Downside* Abbot Snow observed with great sadness:

> The loss to the College cannot be estimated, for it is not represented by money value only; it provided an opportunity, seldom within reach of a college, of organising a thorough system of observations that would command the attention of the scientific world through the magnitude of the glass.
>
> In simultaneous observations of any astronomical event the results from the Downside glass would have always been sought for; it would have been a training in science for the whole establishment, since interest in, and hence knowledge of, the work could not fail to be diffused as a part of the "esprit de corps"; and the observatory provided an unrivalled source of attraction and pleasure to strangers and visitors, for no-one could look through the glass at the more prominent celestial objects without taking away impressions that would never be forgotten.[61]

Norbert Birt adds: 'Fate, however, relegated such daydreams to the lumber-room of "might-have-beens".' [62]

van Zeller, though, indulges in a dramatic flight of fancy: 'If this were an Ibsen play instead of serious history, Mr. Slater would be brought back for the closing scene: the Master Scientist, unable to keep away from the creature of his invention which has betrayed him, and returning in secret on the eve of an astral manifestation, fires the building and himself perishes in the burning – leaving behind him among the trees by the cinder-path a now silent steam-driven tricycle which typifies the neglect of a lesser success in the glare and glamour of a greater failure.' [63]

10. Final thoughts

Over and above the undoubted educational value that having a large telescope available for use by the school pupils would have bestowed, what contribution to astronomy in general might the Downside refractor have been able to make, had it survived? Any assessment is of course compromised by a lack of detailed knowledge of the quality of the instrument. There are no observing diaries to consult and, even if they had been compiled, they would most likely have been destroyed in the fire. All we have to go on are Abbot Snow's disparaging comments in the early part of his narrative and his more emotive description of observations of the Moon and planets later on.

In particular, he states: 'Saturn was a beautiful object, the great power of the glass developing the divisions in the ring and its shadow on the body of the planet; the appearance of the ring when quite perpendicular to the body was a test of the excellence of the glass',[64] which perhaps indicates that things were not as bad as originally stated. The reference to the rings being 'perpendicular to the body' is entirely accurate, as the Earth was then undergoing one of its periodic passages through the ring plane. It must have made quite an impression on a young student for him to have remembered it when writing his book 40 years later.

10.1. *Potential astronomical studies*

Large telescopes at that time often undertook photometric and astrometric work, primarily for the preparation of star charts and measuring the orbits of double stars. Astrophotography did not begin until the 1880s so brightness was estimated by eye and position-measuring was done using a micrometer at the eyepiece. However, such activities would have required a planned, long-term programme of meticulous measurements by dedicated observers, which is unlikely to have fitted in with the constraints of a religious and educational community.

Turning to the planets, the observatory was built too late to have made any of the easier discoveries, and too early to have benefited from the improvements in technique necessary to produce lenses large enough to observe fainter objects.

For example, Phobos and Deimos, the moons of Mars, were not seen until 1877; Amalthea, a fifth moon for Jupiter (after the easily visible Galilean quartet) was not found until 1892; Saturn's moon Hyperion was discovered in 1848, but the next one (Phoebe) was not found until 1899; Uranus' moons Ariel and Umbriel were seen in 1851 but Miranda had to wait until 1948; and Neptune's largest moon Triton was found in 1846 but the next (Nereid) was not discovered until 1949.

The long-suspected innermost ring of Saturn, called the Crêpe Ring because of its tenuous nature, was finally confirmed in 1850 and was also seen with the Craig telescope in 1852. Any planetary observations would have been restricted to recording surface markings, a field which quickly began to develop in the mid-19th century. Detailed observations of the markings on Mars and the belts of Jupiter would easily have been made with a 15-inch refractor.

Finally, there are temporary phenomena, comets being the classic example. We know that Thomas Slater observed Donati's Comet with his own 15-inch telescope in 1858, making drawings which were published in the *Illustrated London News* and can now be found online.[65] Other Great Comets would have been obvious targets for observation from Downside.

Equally unpredictable would have been asteroids, a steady stream of which were discovered in the second half of the 19th century with smaller telescopes than that at Downside; eleven had been discovered with the 7-inch (180-mm) refractor at George Bishop's observatory in Regent's Park in 1847–54.[66] Discoveries were somewhat fortuitous, requiring observers to have good charts of star fields and hence notice an interloper. Regular observation would give the best chance of spotting something, but occasional observations might have struck lucky.

It seems reasonable to conclude, therefore, that given a number of sufficiently interested observers among the religious and educational communities at Downside, a programme of essentially ad hoc observations of planets and comets could have made a significant contribution to the work being carried out elsewhere by a relatively small number of astronomers, mostly amateurs. The destruction of the observatory should thus rightly be regarded as a grievous loss to the astronomical community in the UK. In this year of the 150th anniversary of the fire we can only pose that age-old question: 'What if?'.

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Charles Fitzgerald-Lombard OSB, MPhil, is a Benedictine monk, having been Abbot of Downside from 1990 to 1998, and also parish priest of St Edmund's Parish, Bungay, Suffolk. His association with Downside led him to investigate the history of the Great Observatory, which resulted in him writing an article for *The Raven*, the year-book of Downside School. Having asked his co-author on the present project to proof-read the text of the article, the pair then collaborated on this paper.