

## Caring for the Circle: The Maintenance of the Airy Transit Circle, 1851-1861

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In 1851, the first observation with the Airy Transit Circle was made. The instrument - that 33 years later was chosen to mark the Greenwich Prime Meridian - required the Royal Observatory, Greenwich to implement a new set of maintenance regime for the care of the telescope. The Astronomer Royal - George Airy - was well aware of the practical vulnerabilities of the instrument,<sup>2</sup> and as a result designed the transit circle with those limitations already in mind. For example, the telescope tube can be raised to allow access to the pivots for oiling, and additional telescopes help in determining the errors of the instrument.<sup>3</sup> The new practices of maintaining this monstrous machine had to be learnt and internalised by the observatory staff. The following case study focuses on how such practices became stabilised in the first ten years of the instrument's use.

Those researching the papers of the George Airy are very fortunate historians, as the astronomer is remembered as someone who even preserved the blotting papers upon which he tried his pens out.<sup>4</sup> Due to the abundance of correspondence and notes that survived, the Airy papers can shed light on the maintenance of astronomical instruments carried out by the observatory staff. There remain notes sent to the lowest ranked carpenters, instructing them to oil and clean with a brush the observing chair of the transit circle,<sup>5</sup> to carry out the oiling of the pivots and other parts of the telescope,<sup>6</sup> and to demonstrate these tasks to individuals using similar transit circles.<sup>7</sup> The lower ranked assistants often sent notes to Airy in order to make him aware of the stiffness of the transit circle, or of the squeaking noises the instrument made.<sup>8</sup> Through the senses of hearing and touch, the assistants let the "matter speak" and by applying

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<sup>2</sup> Airy, George, 'Report on the Progress of Astronomy during the present Century', in *Report of the first and second meeting of the British Association for the Advancement of Science*, London: John Murray, Albemarle Street, 1835. pp. 125-189.

<sup>3</sup> Satterthwaite, Gilbert, 'Airy's Transit Circle', in *Journal of Astronomical History and Heritage*, 2001, 4(8), p. 117.

<sup>4</sup> Newcomb, Simon, *The Reminiscences of an Astronomer*. Boston, New York, Cambridge: Houghton, Mifflin and Company, The Riverside Press, 1903. p. 291.

<sup>5</sup> Airy to Green, Royal Greenwich Observatory Archives 6/736 251. In the following footnotes, documents from this archive will be referred to with the abbreviation RGO.

<sup>6</sup> Airy to Green, RGO 6/740 330.

<sup>7</sup> Astronomer Royal's Journal, RGO 6/25 24; Airy to Green, RGO 6/726 452.

<sup>8</sup> Main to Airy, RGO 6/58 240; Dunkin to Airy, RGO 6/58 248.

basic adjustments, they engaged in a material dialogue with the instrument.<sup>9</sup> Another task of the lower ranked assistants was to carry out smaller "experiments" to check if different adjustments would make the instrument more precise.<sup>10</sup> Furthermore, when guests were invited to visit the Observatory, the assistants responsible for the transit circle were in charge of explaining and demonstrating the use of the instrument.<sup>11</sup> We find notes sent to another group of assistants recently (re)popularised by the movie *Hidden Figures* and by Dava Sobel's *Glass Universe: the human computers*. They carried out the necessary calculations to account for the errors of the instrument after observations with the transit circle were made. The correspondence which survived between Airy and the computers demonstrate that even their superintendent had to keep quiet while working through the long sequences of calculations as his quiet mumbling annoyed and distracted the other computers working in the room. Therefore, it was not only the instrument that had to be maintained, but also the order among the staff members.<sup>12</sup>

At the top of the assistant ranks was George Airy's right hand, the First Assistant, who was in charge of the observatory in the absence of the Astronomer Royal. Among his many duties, the First Assistant was asked to supervise the workmen carrying out task around the transit circle (making sure they do not inadvertently adjust the instrument),<sup>13</sup> and to occasionally correspond with the instrument makers regarding the maintenance and repair of the transit circle. Furthermore, he was asked to compile a monthly report on the state of the instruments including all the auxiliary instruments associated with the transit circle such as barometers, observing chairs, roof shutters etc.<sup>14</sup> These reports demonstrate that in the eye of the maintainer, the transit circle did not appear as a single instrument, but rather as an assemblage of heterogeneous entities of the same system.<sup>15</sup> The uniqueness of this report lies in its inclusion of the "external" auxiliary instruments too, in addition to the "nuts and bolts" of its internal components. Therefore, by perceiving the transit circle through the eye of the maintainer, it refers to a system of instruments, both external and internal, functioning in harmony, as opposed to just the small parts that make up the core of the instrument.

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<sup>9</sup> Callen, Blanca, and Criado, Tomas Sanchez, 'Vulnerability Tests: Matters of "Care for Matter" in E-Waste Practices', in *Tecnoscienza*, 2015, 6 (2), p. 25. This work cites J. M. Sanne's work, *Making Matters Speak in Railway Maintenance* (2009) as the source for the expression.

<sup>10</sup> Airy to Henry, RGO 6/729, 122.

<sup>11</sup> Airy to Henry, RGO 6/31 78; Airy to Dunkin, RGO 6/31 79.

<sup>12</sup> Meadows, A. Jack, *Greenwich Observatory, Recent History (1836 - 1975)*, London: Taylor & Francis, 1975, pp. 3-4.

<sup>13</sup> Airy to Main, RGO 6/38 42.

<sup>14</sup> See Reports on the State of the Instruments, in RGO 6/60.

<sup>15</sup> Callen and Criado, *Ibid.* p. 27.

With all these roles assigned, George Airy, the Astronomer Royal, was not remembered as someone who engaged directly with the instruments around the observatory. In fact, he made only one official observation with the very instrument he designed.<sup>16</sup> As a result of the Astronomer Royal not participating in the mundane/everyday work of the observatory, most of the attention by historians has been paid to the division of labour introduced by Airy to the observatory after his arrival.<sup>17</sup> The use of “skeleton forms” by the computers and the observers which prescribed what calculations to perform at each stage, is one of the examples used to highlighting the increased specialisation and decreased complexity of tasks in the operations of the observatory.<sup>18</sup>

Studying the maintenance of the Airy Transit Circle expands on this interpretation by characterising Airy as a practitioner of remote, yet centralised micromanagement. He requested any user of the transit circle to report to him of any issue with the instrument if he was around the observatory, so that he can be aware of the ongoing activities within the observatory. When the First Assistant was late with his report on the state of the instruments, or when he did not provide sufficient details about the transit circle, Airy reprimanded him for his lazy work.<sup>19</sup> Similarly, the Astronomer Royal instructed the carpenters and the labourers with meticulous attention to detail when it came to carrying out work on the transit circle.<sup>20</sup> This approach was extended to people engaged in the maintenance and repair of the transit circle even outside the boundaries of the Observatory. A letter sent from Airy to Troughton & Simms (the instrument maker firm that was in charge of the manufacturing the transit circle, as well as its subsequent repair) shows us that the Astronomer Royal was aware of his close yet only indirect involvement with the instrument. In this letter, he sent over his design for a screw head for the adjustment of the micrometers of the microscopes attached to western piers of the instrument. To contrast the miniscule size of the artefact with its closeness to Airy’s heart and the significance he attributed to it, he labelled it as another one of his “humble contrivances” which he had been instructing the instrument makers to create.<sup>21</sup>

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<sup>16</sup> Satterthwaite, *Ibid.* p. 131. Though in the Astronomer Royal’s Journal, he noted engaging in the cleaning of some of the micrometers of the transit circle (RGO 6/25 55). Similarly, the report on the state of the instruments from 1871 has a note added to it with pencil stating that the object glass of the telescope tube was cleaned by the Astronomer Royal (RGO 6/62 355). Finally, it should also not be forgotten that the Transit Circle was designed by him.

<sup>17</sup> See Smith, Robert W, ‘A National Observatory Transformed: Greenwich in the Nineteenth Century’, in *Journal for the History of Astronomy*, xxi, 1991, pp. 5-20.

<sup>18</sup> See Schaffer, Simon, ‘Astronomers Mark Time: Discipline and the Personal Equation’, in *Science in Context*, 2(1), 1988, pp. 115-145.

<sup>19</sup> Airy to Main, RGO 6/60 625.

<sup>20</sup> Airy to Green, RGO 6/736 245.

<sup>21</sup> Airy to James Simms, RGO 6/743 1037

So what does this case study tell us about the the maintenance of the instrument? First, the case study shows us that maintenance was not exclusively exercised by the instrument makers (or external contractors), but rather, it was also carried out by the observatory staff. Parallel to instrument making moving away from the observatory as a site, the local maintenance and minor repair practices remained within the observatory. During the first ten years of the Transit Circle's operation, "local" maintenance roles had to be assigned: the carpenter carried out the lifting of the instrument to be able to oil and clean the pivots upon which the east-west axis of the telescope rests; the assistants carried out the measuring of the errors of the instruments an hourly basis, and advised Airy on how to improve the instrument; the first assistant compiled reports on the state of the instrument, supervised the work carried out by workmen on and around the transit circle, and corresponded with the instrument makers. Some of these roles often overlapped in the beginning. The assistants, for example, carried out adjustments on the instrument with the help of the carpenter.<sup>22</sup> The First Assistant would also take part in this experimenting with the adjustments.<sup>23</sup> Similarly, when the staff of the Royal Observatory at Cape of Good Hope visited the observatory at Greenwich, it was the he carpenter who was asked by Airy to teach the visiting First Assistant on how to carry out the essential maintenance of transit circles in general, thus demonstrating that knowledge was transferred from industrial grade labourers to high-level assistants.<sup>24</sup>

The material used for the maintenance practices also had to be agreed upon. There was much discussion on the type of oil to be used, and during what periods different types should be used. This was settled on the use of sweet almond oil during winter and the use of sperm whale oil during the warmer months.<sup>25</sup> Correspondence survives on discussions about when to carry out the lifting and the essential maintenance of the transit circle. Airy suggested 10am on either every Tuesday or Saturday.<sup>26</sup> Yet, by the end first ten years, this was moved to Mondays.<sup>27</sup> Lastly, while it resembled more of a monologue, Airy sent instructions to the carpenter on what equipment to use for the cleaning and what type of outfit to wear during lifting and oiling of the instrument.<sup>28</sup>

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<sup>22</sup> Airy to Green, RGO 6/730 388.

<sup>23</sup> Main to Airy, RGO 6/29 108.

<sup>24</sup> Airy to Green, RGO 6/726 452.

<sup>25</sup> Airy to Green, RGO 6/729 239; Airy to Main, RGO 6/37 5.

<sup>26</sup> Airy to Main, RGO 6/37 21.

<sup>27</sup> Airy to Green, RGO 6/727 508.

<sup>28</sup> Airy to Green, RGO 6/736 251.

The case study also tells us a bit more about on how Airy perceived the dynamic between the astronomers and instrument makers. As mentioned above, on a few occasions Airy requested his first assistant to be present during the adjustment and repair of instruments on-site carried out by the workmen of Troughton & Simms, because Airy feared that the workmen might unintentionally adjust the instruments in the wrong way.<sup>29</sup> Similarly, a note sent from Airy to Main instructs the first assistant never to consult an optician until he checked the theory behind the fault since “we [the astronomers] understand the theory far better than they do.”<sup>30</sup> In brief, the maintenance of the instrument was just as much a theoretical exercise as practical task. But while it engaged both the craftsmen and the theoretician, Airy seemed to have considered the work of the astronomer (theoretician) as taking priority.

Finally, the examination of maintenance highlights the restrictions on improvisations not as a measurement of knowledge, but rather, as a reflection on the hierarchical position and status of the member of staff. While the assistants were asked to test out Airy’s ideas on how to improve the performance of the instrument, the carpenter was always asked to follow detailed instructions.<sup>31</sup> Therefore, the practice of improvisation becomes a symbol for the position of the member of the observatory staff within the hierarchy of the Observatory, where the increased freedom to improvise signalled a higher rank. By contrast, when measuring the impact that each one of the maintainers had on the care of the instrument, the inequalities disappear, and the contribution of each individual seemed to be just as significant. For example, when the carpenter asked to go on holiday, he remarked how he had not taken a break for the last three years. While Airy allowed the carpenter to leave for a week, he was asked to begin his “holiday” on a Tuesday, so that the raising of the telescope (part of the essential weekly maintenance) is only omitted for one Monday, thus signalling Airy’s and the observatory’s reliance on the carpenter’s specialised set of skills and knowledge.<sup>32</sup>

In summary, the documents surviving from Airy’s directorship of the Royal Observatory, Greenwich, provide us a glimpse into how the maintenance of an era-defining instrument was organised during the second half of the nineteenth century at a major scientific institution. Practices of maintenance appear to have been defined by the division of labour and the assignment of specialised role prevalent at British industrial sites. As a result of this, the freedom the improvise during the maintenance of the Transit Circle emerges as a main measure

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<sup>29</sup> Airy to Main, RGO 6/38 42.

<sup>30</sup> Airy to Main, RGO 6/29 97.

<sup>31</sup> Airy to Green, RGO 6/736 245.

<sup>32</sup> Green to Airy, RGO 6/727 504; Airy to Green RGO 6/727 508.

to identify the position of the maintainer within the hierarchy of the Observatory's organisational structure. However, occasional examples also emerge, where the director of the Observatory participated directly in the maintenance practice, thus demonstrating that the remote control of the observatory staff was not as rigid as previous accounts might imagine.