Refereed article

The 1882 transit of Venus and the Huguenot Seminary for Girls

W P Koorts
South African Astronomical Observatory, PO Box 9, Observatory, 7935
wpk@saao.ac.za

Abstract. The Huguenot Seminary in Wellington, South Africa, was established in 1874. Its first Principal, Abbie Park Ferguson, was a keen amateur astronomer and friend of Sir David Gill, and taught astronomy there from its inception. In 1882 the Seminary acquired a 6-inch Fitz refractor which was set up in an observatory in time for the transit of Venus across the Sun on 1882 December 6.

Simon Newcomb, leader of an American transit expedition, established an observing station alongside the Seminary Observatory and helped the school to make their own observations. When the Americans departed, they left behind their instrument mounting piers. In his autobiography, Newcomb expresses a sentimental wish that these will again be used when the next transit occurs in 2004. However, by 1936, most of these relics had disappeared.

Measurements on the present terrain reveal that all traces of the American station and the Seminary Observatory have disappeared. Also unaccounted for is the 6-inch Fitz refractor. An effort is being made to fulfil Newcomb's dream as far as possible during the next Venusian transit on 2004 June 8.

Keyword: history of astronomy

Astronomy at the Huguenot Seminary for Girls

During the late nineteenth century Rev. Andrew Murray, the well-known Dutch Reformed minister in Wellington (see Figure 1 for localities mentioned in the text), identified the need for a higher educational institution for girls in South Africa. While on holiday at the Murray's seaside cottage 'Patmos' in Kalk Bay, near Cape Town, he was reading a copy of *Memoir of Mary Lyon*, founder of the Mount Holyoke Seminary in South Hadley, Massachusetts, USA. He wrote to the principal (a copy of this letter is kept in the Wellington museum) asking for one teacher to start a similar school in Wellington, modelled on the pioneering work Lyon did in the field of Christian education for girls in America. Soon afterwards he received an answer saying they could, in fact, send two teachers and, on Monday 19 January 1874 the 'Huguenot Seminary for Girls' opened with Miss (later Dr) Abbie Park Ferguson and Miss (later Dr) Anna E. Bliss at the helm. There were 40 boarders in 'White House' residence and 14 in the village (Ferguson 1927).

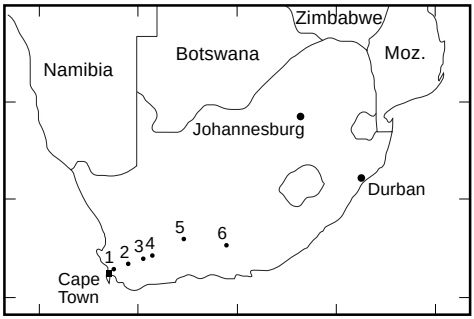
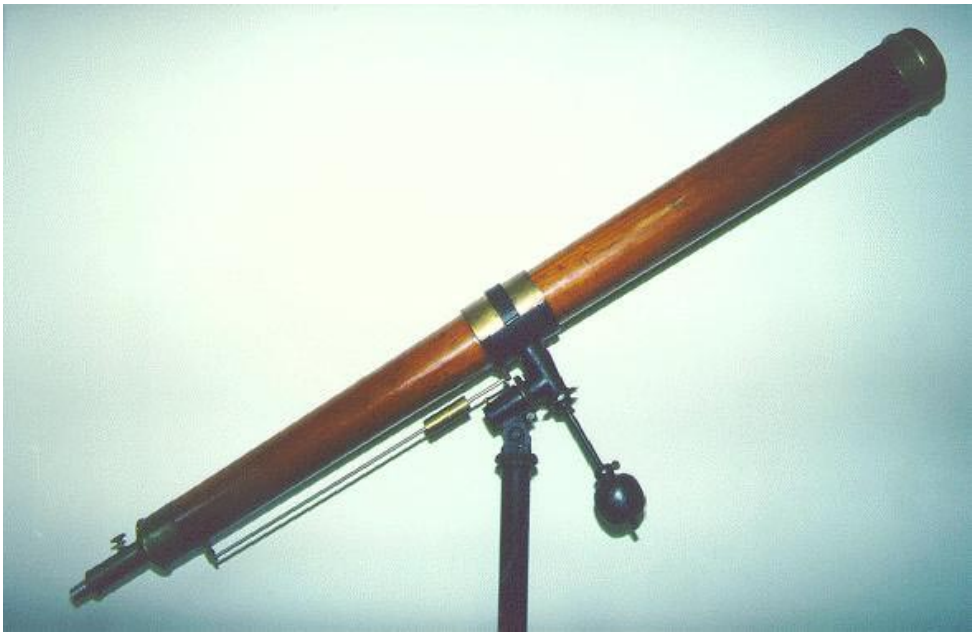


Figure 1. Localities mentioned in the text. (1) Wellington, (2) Worcester, (3) Touws River, (4) Matjiesfontein, (5) Beaufort West, (6) Aberdeen Road.

Figure 2. (left) Abbie Park Ferguson (left) and Mary Elizabeth Cummings, later Mrs Gamble (right), photographed c.1880, two of the Seminary staff who observed the transit of Venus in 1882 (Ferguson 1927: 16, 64). **Figure 3**. **(below)** This 6-inch Fitz refractor from the private collection of John Briggs is probably a twin of the missing telescope that once stood in the garden of the Huguenot Seminary in Wellington. The telescope pictured here was originally set up at Trinity College, Connecticut, USA. Although it was installed there after 1882, its acquisition by Trinity was inspired by the 1882 transit of Venus. Briggs would eventually acquire it from Trinity a century later.



Miss Ferguson (Figure 2) was always interested in astronomy, having the "… knowledge of a keen amateur, quite sufficient to infect others with her enthusiasm and to give them the knowledge they needed to read books intelligently." (Ferguson 1927: 48) From the start she offered an astronomy class at the Seminary and, since she was a personal friend of Dr (later Sir) David Gill, Astronomer Royal at the Cape, he would often visit Wellington and give lectures to the class. By this time Gill was already an international figure in astronomy (Forbes 1916).

In 1881 the Williston Observatory was built at Mount Holyoke and furnished with a new 8-inch Clark refractor (Warner and Ariail 1996: 135-137). The Seminary's original telescope, a 6-inch Fitz refractor (first installed there in 1853), was then given to the Hu-

guenot Seminary in Wellington (cf. Figure 3). Under Gill's supervision it was erected in a small, round 'rondawel'-type observatory (see Figure 12, p. 194) on the northern (rear) side of Murray Hall (Huis Murray today) just in time for the transit of Venus on 6 December 1882.

Figure 4. Simon Newcomb, 1835–1909 (Dick 1988: 243).

Transits

The year 1882 was special in astronomical terms for two reasons. For one, the Great Comet of 1882 (C/1882 R1) appeared, becoming bright enough to be seen in daytime. In photographing this, Gill realized the potential of photography in astronomy (Lankford 1984) and started a new era of observational astronomy. Secondly, it was the last time – until the years 2004 & 2012 – that a transit of the planet Venus across the Sun's disk would occur.

Only the inner planets, Mercury and Venus, can show this phenomenon which occurs when they are situated between the Earth and the Sun. In contrast to Mercury, where transits happen at a rate of 13 to 14 per century, transits of Venus are very rare (to date, only five have been observed). Venusian transits happen in pairs, eight years apart, which repeat only after more than a century. Previous transit pairs were in 1761 & 1769 and 1874 & 1882 (it was to observe the 1769 transit from Tahiti that Cook's first voyage to the South Seas was undertaken – see Orchiston 1998).

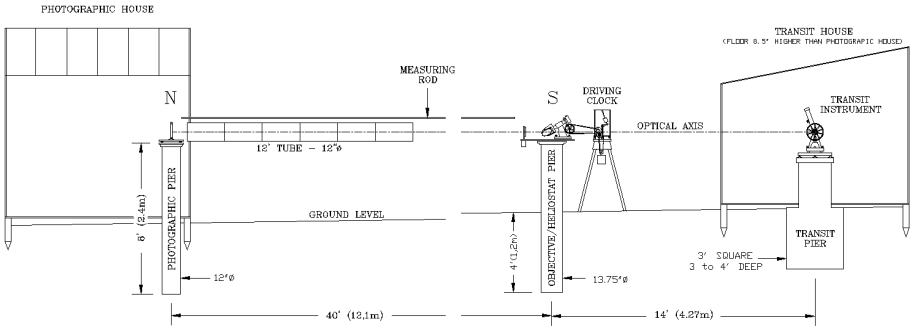
As early as 1609 Kepler could very accurately determine the orbits of the planets by using his laws, but only after (at least) one distance was accurately measured, could the others be deduced with equal precision. One direct method of determining the distance between the Earth and Sun is to observe the transit of Venus simultaneously from different places on the globe.

Newcomb chooses Wellington

After the success of its 1874 transit program (Dick et al. 1998; Janiczek & Houchins 1974), the Americans dispatched transit parties to South Africa, New Zealand and South America for the 1882 event. Leading the South African party was Simon Newcomb (Figure 4) of the US Naval Observatory (USNO). Newcomb was already very well-known internationally, but his reputation would continue to grow until he became the most honoured American astronomer of the 19th century – a crater on the Moon was even named after him.

Gill originally suggested that the American party should observe the transit from Beaufort West. However, when Newcomb heard about the American connection with the Hu-

(5a)



(5b)

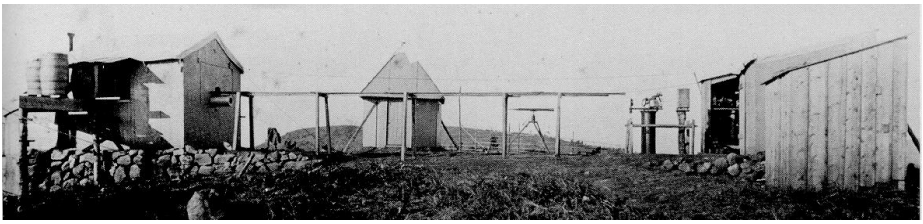


Figure 5 (above). (a) A scale drawing of the layout of a typical southern station of an American observation post in 1882. (b) The 1874 Nagasaki observing station, showing from left to right, the photographic house, measuring rod, lens & heliostat, clock drive, meridian transit house and storehouse. At the back is an octahedral telescope hut and a small telescope. (Janiczek & Houchins 1974: 370)

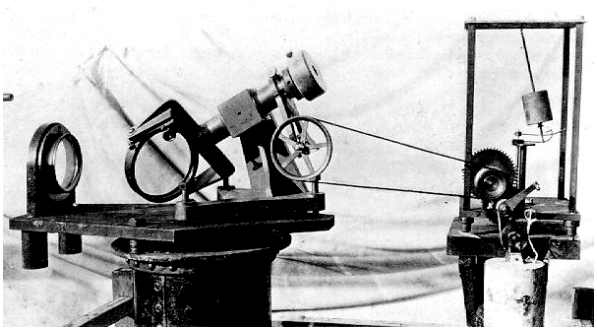


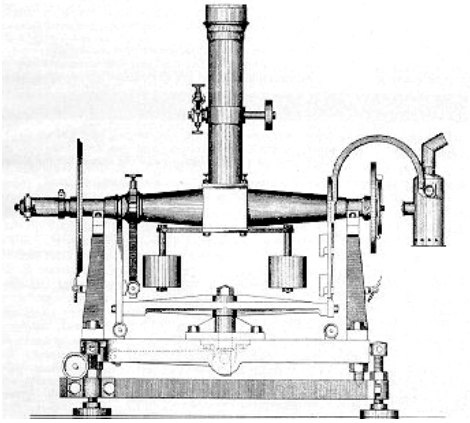
Figure 6 (right). The southern pier carried the objective lens (left) and the unsilvered heliostat mirror, driven by a clockwork (right). (Janiczek & Houchins 1974: 367)

guenot Seminary, he decided to use the Seminary grounds as his observing site and, by arrangement with the trustees, set up his equipment in the garden there (Stone 1883).

The 'equipment' comprised a horizontal photographic telescope, a standard refracting telescope, a transit telescope, a sidereal clock, box chronometers, a chronograph, and various meteorological instruments (Figure 5).

Layout of Newcomb's Wellington site

Using two USNO publications, *Instructions for Observing the Transit of Venus, December 6, 1882* and *List of Articles Furnished to the United States Transit of Venus Parties in December 1882*, I made a scale drawing of the makeup and layout of Newcomb's observing post in Wellington (Figure 5a).



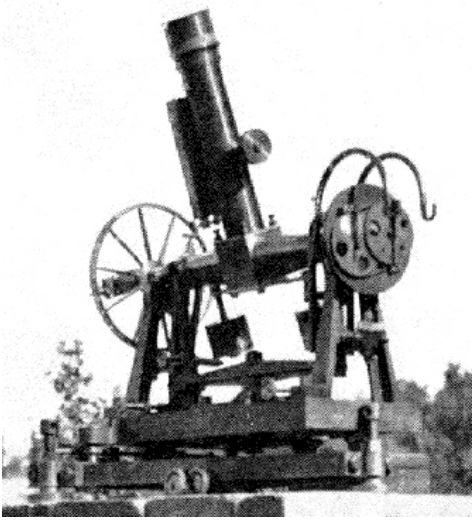


Figure 7. (**above**) The transit instruments used to determine latitude and time. These were Stackpole telescopes of 'broken-tube' design with a 2.5 inch clear aperture and 30 inch focal length. The viewing eyepiece was at the far end of the horizontal part, behind the spoked setting circle. A prism in the centre reflected the image into the eyepiece. The two hooks on the right were used to carry the oil lamp illuminating the cross hairs. (Janiczek & Houchins 1974: 369) (**right**) An instrument used on the USNO expeditions to observe the solar eclipses of 1900 and 1901. It is identical to the instruments that were used by the transit of Venus parties. (*Pub. USNO*, Second Series, vol. IV, part IV, plate V)

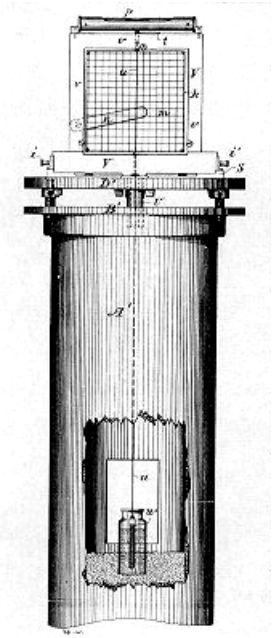


Figure 8a. (**left**) The photographic pier carrying the plateholder with the glass reticle directly in front, seen here in the direction from which the plates were exposed. On top is a spirit level and at the bottom the plumb bob hanging from a thin silver wire, steadied by immersion in a glass jar filled with water. An image of the reticle and silver wire was recorded, superimposed on that of the Sun. (Newcomb 1880: Appendix, Fig 4)

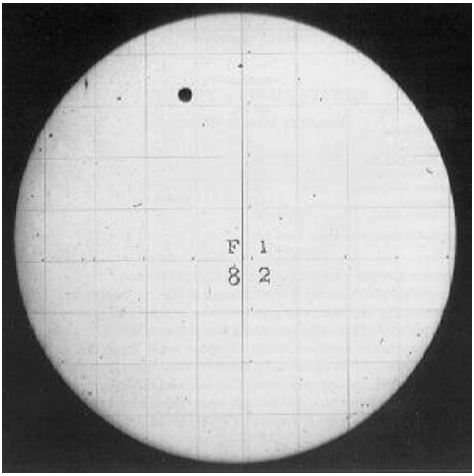


Figure 8b. (**right**) Example of a US photograph of the 1882 transit in progress. (Dick, Orchiston & Love 1998: 240)

The telescope was effectively a static, horizontally-mounted photo-heliograph of 12.1 m (40 feet) focal length, fed by a clock-driven unsilvered heliostat mirror (Figure 6). Crucial were two hollow cast-iron pillars, 2.4 m (8 feet) long with the lower half set into the ground, "preferably in concrete". The pillars were placed on an exact north-south line, 12.1 m (40 feet) apart. The diameter of the northern pillar was 305 mm and 350 mm for the southern pillar. Exactly 14 feet (4.27m) south of the southern pillar and on the same line as these two pillars, was another pier on a concrete foundation of roughly 1m (3 feet) square, 1–1.25 m (3 to 4 feet) deep, upon which stood a transit instrument (Figure 7). This instrument was used to accurately determine the north-south line for the main telescope by observing the stars and was therefore placed exactly on its optical axis. It was also used to provide an accurate time-service. The 'Transit House' was built over the transit telescope with a roof having a north-south slit giving access to the sky.

Around the northern (photographic) pillar (Figure 8) the 'Photographic House' was built where the glass photographic plates were exposed and developed, thus acting as both photographic studio and darkroom. The thicker southern pillar carried the heliograph objective lens as well as the driven heliostat mirror but was not housed in a hut. The correct focus setting was determined through a complicated routine of determining the temperature of the measuring rod (Figure 5a) and the distances from its ends to the objective and photographic plate by means of a special micrometer (Figure 9 shows expedition members practicing with the equipment).

Apart from the photographic observations, each American station was equipped with an ordinary telescope (a 5-inch Alvan Clark equatorial refractor, Figure 10) for making 'contact observations'. First and second contact took place as the disk of Venus moved onto the Sun and third and fourth contact as Venus cleared the Sun's disk. (Only the first and second

Figure 9. Participants of the 1874 expeditions are seen here on the grounds of the USNO practising the big event. Newcomb is seated in front and in the background and extreme right are some of the wooden huts that were used in the expeditions. The size of a pillar (extreme left) can be compared here against that of a person. (Dick, Orchiston & Love 1998: 233)

Figure 10. This 5-inch refractor from the private collection of John Briggs is a perfect twin to the original eight 'USNO, Transit of Venus telescopes' made by Alvan Clark & Sons, complete with their unmistakable signature wrapped around the tailpiece (Warner & Ariail 1985). Although this telescope is dated 1875 (the USNO Transit of Venus telescopes were all dated 1874) it bears no serial number and instead carries the beautifully hand-painted words 'Abbot Female Academy' on an iron casting inside the transportable pillar. Briggs traced the history of this telescope, verifying it being a ninth USNO Transit of Venus telescope, made by the Clarks, presumably as a backup in case something happened to one of the original eight. He found some surviving correspondence about the early plans for a telescope at Abbot Academy where the school originally envisioning another Clark telescope (a 7½-inch) which evidently they never got. It seems as though another telescope became available instead (this 5-inch) and after some challenging fundraising, they snapped it up.

contacts were visible from South Africa in 1882 – the transit was still in progress at sunset.) This telescope was housed in a prefabricated octagonal building which had a square pyramid-shaped roof that could turn through 360° and incorporated a vertical slit which could be opened (Figure 5b, centre). A fourth building in the observing precinct served as a store room for the party's supplies.

The American observations

Fine weather greeted the astronomers on the day of the transit, 1882 December 6, and Newcomb (1903: 177) proudly reported that "… all our observations were successful."

Then came the challenge of reducing these observations and those obtained by the other US transit parties, a task assigned to fellow-US Naval Observatory astronomer, William Harkness (Dick et al. 1998). Despite a succession of frustrating funding cuts, in 1888 Harkness reported a value of 8″.847 ± 0.012 for the solar parallax (Annual Reports 1888: 17-18), and just six months later revised this to 8″.842 ± 0.0118 (Annual Reports 1889: 424-425). These figures can be compared with the modern value of 8″.794148 ± 0.000007, equating to a mean solar distance of 149 597 870 km, which was officially adopted by the International Astronomical Union in 1976 on the basis of radar measurements.

Never in their wildest imagination could Harkness and Newcomb have known that distances in the solar system would one day be refined to metres by bouncing radar signals off Venus or to within centimetres by reflecting laser light from a mirror put on the Moon by astronauts!

The Huguenot Seminary observations

The Seminary's observatory conveniently "… stood alongside the more perfect instruments of the professional observers." (Ferguson 1927: 48) Newcomb encouraged the teachers and students to take part in the observations and set them up well enough so that they eventually observed the transit through their own telescope.

Today the names of Miss ME Cummings, Miss AP Ferguson and Miss JN Brown can still be found listed amongst those of the professionals, each being credited with a transit observation (US Transit of Venus Commission 1883). The author of *Builders of Huguenot* even claims that the amateurs made better observations than the professionals! Newcomb's reply was that "… it was partly the result of good fortune, and partly due to the quickening of the faculties which comes with intense interest," but the ladies took it "… as a tribute to the greater powers of their own sex." (Ferguson 1927: 48-49)

These events are probably best described in a letter written by one of the observers soon after the transit:

> "I must tell you of our telescope before I close. Some of you perhaps know that it is the one through which we had a few peeps when pupils of Mt. Holyoke. When it was no longer needed there, Mr Williston kindly presented it to the So. African daughter of Mt. Holyoke. An observatory was erected for it in our garden, and the telescope was mounted under the direction of Dr Gill, the Astronomer Royal, from Cape Town. It was scarcely in order when the "Transit of Venus Expedition" from the United States, arrived in Cape Town, and soon after decided upon Wellington as the best astronomical station for their purpose. Our garden was selected as the best site, all things considered, and four buildings were erected. Prof Newcomb, the Chief of the Expedition, instructed the pupils in Miss Ferguson's astronomy class and several of us teachers, in the art of reading time quickly on the chronometer, and several of us were invited to share the practice of the astronomers, in observing an artificial transit of Venus, by means of an apparatus invented by one of the party. The actual transit took place the day before our anniversary and in the midst of the examinations and hurry of anniversary week, and to several of us teachers was the most important event, as it had been arranged that we should observe it through our own telescope, which was in excellent condition and gave a splendid view of all that could be seen." (Cummings 1882)

Similar observations were also made from Cape Town, Durban and Aberdeen-Road under Gill's direction, while a British expedition used Montagu Road (Touws River today) as their observing base (for details, see Stone n.d.).

Hunting for relics

H.E. Wood from the former Union Observatory in Johannesburg made a plea in the *South African Journal of Science* for the retention of these important historic landmarks (Wood 1937).

In Touws River the two concrete pillars used by the British party still existed in the courtyard of the former Douglas Hotel, complete with a hand-written inscription of the names of the astronomers (Figure 11). Instigated by Wood, and with the permission of the then-owner of the hotel, the legendary Mr James D. Logan of Matjiesfontein, these relics

were declared a National Monument in 1938.

Physical remains were also left when the American party quit the Seminary site after the transit, and in his autobiography Newcomb nostalgically recalled the transit 20 years earlier:

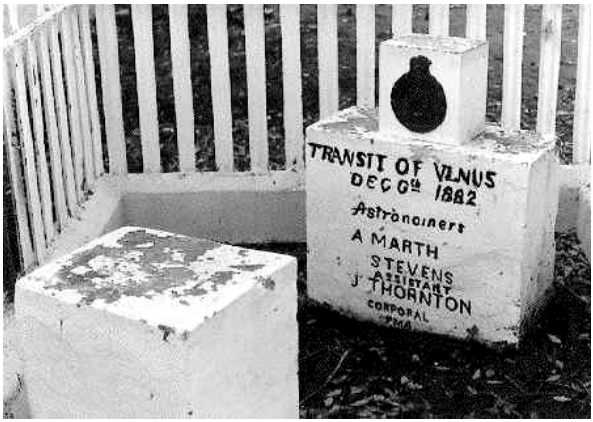


Figure 11. The two pillars left by the British expedition to Touws River.

> "On our departure we left two iron pillars, on which our apparatus for photographing the Sun was mounted, firmly imbedded in the ground, as we had used them. Whether they will remain there until the transit of 2004, I do not know, but cannot help entertaining a sentimental wish that, when the time of that transit arrives, the phenomenon will be observed from the same station, and the pillars be found in such a condition that they can again be used." (Newcomb 1903: 177)

In his article Wood also quoted Newcomb's sentimental wish and writes further:

> "Unfortunately the iron pillars left behind by Newcomb have not remained undisturbed. Their existence has been forgotten and the piers have disappeared. Upon enquiries being made in April 1936, it was found that one of the garden boys remembered the position where one of the pillars had been and, on excavating, a foundation was found. At this spot an iron post has been erected to mark the site at which Newcomb's observations were made." (Wood 1937)

Too few physical remains survived at the Wellington site for it to be declared a National Monument. The iron post has also since disappeared, probably because it was never properly marked and therefore the reason for its erection unexplained.

In answering a query from a member of the public asking about the Touws River monument, a former director of the National Monuments Council, Mr B. D. Malan, replied in July 1963 as follows:

> "An American expedition under Prof Simon Newcomb erected instruments for the same purpose on the site of the Huguenot Seminary, Wellington, at a spot which is nowadays indicated by an iron standard placed there in 1936."

From this it can be deduced that the post still existed in 1963, but it could also have been that Mr. Malan simply consulted the Council's Touws River file which includes a copy of the Wood article. His reference to the post as an 'iron standard' is very interesting, suggesting a larger free-standing post, a common name given to ornamental (gas) lamp posts in former days, compared to Wood's description of an 'iron post' which rather brings to

Figure 12. In this section of an aerial photograph of Wellington taken about 1937, the possible post erected by Wood in 1936 (bottom-left) and the Seminary observatory (bottom-right) are clearly visible. The large building (top-left) is Goodnow Hall with Murray Hall in the centre and 'White House' (demolished today) to its right. (Photo: Wellington Museum)

mind a smaller fencing-type corner-post. This compares well with a solitary post just visible on a 1937/38 aerial photograph of Wellington (Figure 12), discovered in the Wellington Museum. Taking into account that this photograph was taken only a year or two after Wood's visit, this post could well have been the one erected by him.

A slightly puzzling aspect of Wood's report is that he only refers to one post. Given the above description of the apparatus, it is clear that as soon as the position of any one post is known, the other's location is automatically determined – it must be either 40 feet due north or 40 feet due south. If Wood had measured the thickness of the post from the foundation, it could have been identified as either the northern or southern pillar, fixing the direction to the other one. It could thus have been that either Wood did not have detailed knowledge of Newcomb's instrument or that the foundation of the other pillar had disappeared by then.

The Seminary observatory has proved equally elusive. With the 60th anniversary of the Seminary in 1933, Mary Cummings (then Mrs Mary Gamble) wrote down a few of her reminiscences of her ten years (1877–1887) at the school. She refers to the transit observations, which seem to have made a lasting impression on her, and also mentions that regrettably the telescope was not used much after those early years (probably because astronomy as a subject was discontinued by about 1890 when the matriculation system was introduced). Years later, Miss Ferguson reflected on the first 15 years as follows:

Figure 13. A postcard, dated 1935, found in the Wellington Museum, has the caption: "The Garden from the back of Murray Hall. Observatory on the left, Music Rooms on right." This verifies the location of the observatory building on the 1937 aerial picture. (Those familiar with Wellington will recognise the large tree on the horizon, still there today.)

> "How did we enjoy the broad outlook in Literature, the nights with the telescope under the stars, the excursions into the realms of Science and the deep problems of Philosophy." (Ferguson 1927: 120)

Cumming's writings imply that the observatory still existed in 1933. If one compares this information with the aerial photograph of Wellington (Figure 12), a small white building can be made out. Its position was

Figure 14. The Seminary observatory, photographed in 1932. (Photo: Wellington Museum)

confirmed with the discovery of a 1935 postcard (Figure 13) and a close-up picture dated 1932 (Figure 14).

It is strange that in his report about the remains of the American observing station, Wood (1937) never refers to the Seminary observatory, which might mean that he was unaware of its use in observing the transit.

By taking careful measurements of this post from the aerial photograph and applying it to the present terrain behind Murray House, I was able to determine that this position falls just outside the rear garden, in the middle and at the extreme eastern end of a tarred footpath that runs alongside an approximately 1.5 m high retaining wall holding the garden soil back from excavations made for building tennis courts. (For the record, this position is 40.03±0.3 m east and 47.35±2 m north of the north-eastern-most corner of the present Murray House.) Measurements using a metal detector have not shown up anything definite.

My best hope to pinpoint the location is to find the written directions which, according to the document *Instructions for Observing the Transit of Venus, December 6, 1882*, was to accompany a map drawn up for finding the observing site again. This document had to be included in the observing report which is apparently kept in the National Archives in Washington DC. Getting hold of a copy has thus far proved very difficult.

The transit in 2004

Almost the entire 2004 transit will once again be visible from Wellington (Figure 15). When the Sun rises over the town on 2004 June 8 the transit will have just started at 07:13 and it will take Venus until 13:26 to cross the disk of the Sun (Meeus 1958). With sufficient optical filtering from the harmful sunlight, the black dot of Venus, silhouetted against the bright Sun, will even be visible to the naked eye. A near-identical 'dress rehearsal' took place exactly one year, one month and one day before the time with a transit of Mercury

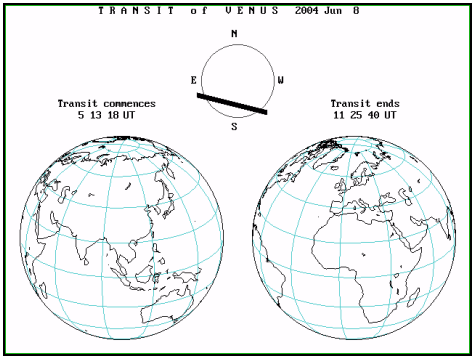


Figure 15. Transit of Venus, 2004 June 8, as seen from Wellington. The radius of the Sun will be 945.4'' and of Venus, 28.9''. Third contact is at 13:11:01 and fourth contact at 13:29:34. From *Occult* by David Herald.

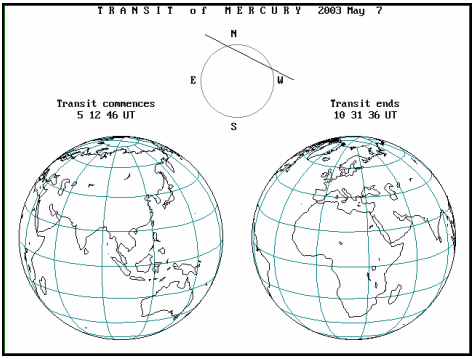


Figure 16. Transit of Mercury, 2003 May 7, as seen from Wellington. The radius of the Sun will be 951.1'' and of Mercury, 6.0''. Third contact is at 12:26:29 and fourth contact at 12:30:57. From *Occult* by David Herald.

(Figure 16). Also starting at 07:13 it took the planet until 12:32 on the afternoon of 2003 May 7 to cross the Sun. Because of Mercury's smaller size and greater distance, it required a telescope or binoculars fitted with adequate eye protection to be visible.

Because the value of the solar parallax is now well-determined, the 2004 transit will be of little scientific interest to professional astronomers, but if I eventually manage to pin-point the position of Newcomb's observing site, I would very much like to fulfil his wish and observe the 2004 transit from this location. It would also be appropriate to then mark the spot more permanently with a plaque.

A missing six inch

This re-enactment would be perfect if it could also be done with the Seminary's original telescope, the 6-inch Henry Fitz refractor. I am currently trying to locate its present owner with the view of joining us in this event and would appreciate any help in this regard. The most recent reference to the telescope I could find dates to 1948 October when the school gave permission for it to be sold to the 'Sterrekundige Vereniging' (Astronomical Society) in Worcester on request of a certain Mr de Villiers.

I managed to track down the daughter of this Mr Walton de Villiers who indicated that her father never owned this telescope. This was verified by the late Danie Overbeek, one of his fellow amateurs when they later moved from Worcester to Johannesburg. No trace of the Worcester Astronomical Society could be found either.

Acknowledgements

What started out as a personal quest, turned into a full-blown research project that would have been very incomplete without the continued assistance, help and encouragement of a number of people. I would therefore like to sincerely thank Ethleen Lastovica (SAAO library), Patricia Albright (Mount Holyoke College Archives), Janie van Zyl (CSIR Archives, Pretoria), Prof Brian Warner (University of Cape Town), Dr Stephan Dick (USNO, Washington DC), Albert Jansen (Prince Albert Town Observatory), Dr Jurie Joubert (Cape Technikon, Wellington Campus), Ansie van Vuuren (Wellington Museum), Dr Etienne Smit (Wellington Viva 2000 research project), the Drakenstein Municipality (Wellington office), Bernett Scholtz (National Monuments Council, Cape Town office), John Briggs (Apache Point Observatory, New Mexico) and Dr Wayne Orchiston (Anglo-Australian Observatory, Australia). Special thanks to John Briggs for permission to publish Figures 3 and 10 taken of his vast antique telescope collection and the Wellington Museum for Figures 12, 13 and 14.

About the author: Willie Koorts was born in Touws River and stayed there until the end of his Matric year. He later met Rieks Wessels while she studied Social Work at the Huguenot College and was resident in Cummings Hall. They presently live in Wellington where Rieks is a former social worker at the Murray Children's Home and his son is attending the Huguenot High School. Willie works as an Electronic Technician at the SAAO in Cape Town and is also an amateur astronomer. He has recently been voted committee member of the IAU Commission 41, Transits of Venus Working Group for the 2003–2006 triennium.

References

Annual Report. US Naval Observatory, Washington (1888).

Annual Report. US Naval Observatory, Washington (1889).

Cummings M.E. (1882) Letter to old class mates, dated December 22. In Mount Holyoke College Archives and Special Collections.

Dick S. J., Orchiston W. & Love T. (1998) Simon Newcomb, William Harkness and the nineteenth century American transit of Venus expeditions. JHA, 29, 221.

Dick S. J. (1988) Discovery of the Moons of Mars. Sky & Telescope, September, 243.

Ferguson G. P. (1927) The Builders of Huguenot. Maskew Miller, Cape Town.

Forbes G. (1916) David Gill. Man and Astronomer. Memories of Sir David Gill, K.C.B., H.M. Astronomer (1879-1907) at the Cape of Good Hope. Murray, London.

Janiczek P. M. & Houchins L. (1974) Transits of Venus and the American expedition of 1874. Sky & Telescope, December, 366.

Lankford J. (1984) The impact of photography on astronomy. In Gingerich, O. (ed.). The General History of Astronomy. Volume 4. Astrophysics and Twentieth Century Astronomy to 1950: Part A. Cambridge University Press, Cambridge, 16.

Malan B. D. (1963) Touws River monument. In National Monuments Council, Cape Town office (Touws River File).

Meeus J. (1958) The Transits of Venus, 3000 BC to AD 3000. JBAA, 68, 98.

Newcomb S. (1878) Popular Astronomy. Macmillan and Co., London.

Newcomb S. (1880) Observations of the Transit of Venus, December 8-9, 1874. Government Printing Office.

Newcomb S. (1903) The Reminiscences of an Astronomer. Harper and Brothers, London.

Orchiston W. (1998) From the South Seas to the Sun: the astronomy of Cook's voyages. In Lincoln, M. (ed.). Science and Exploration in the Pacific. European Voyages to the Southern Oceans in the Eighteenth Century. Boydell in association with the National Maritime Museum, Woodbridge, 55.

Stone E. J. (n.d.) Transit of Venus, 1882. Her Majesty's Stationery Office, London.

Stone E. J. (1883) Meeting of the Royal Astronomical Society, Friday, 1883, January 12. The Observatory, 70, 33.

US Transit of Venus Commission (1883) Transit of Venus, Dec 6, 1882. The Sidereal Messenger, 2(8), 236.

Warner D. J. & Ariail R. B. (1996) Alvan Clark & Sons, Artists in Optics. (2nd ed). Willmann-Bell, USA.

Wood H.E. (1937) Astronomical relics at Touws River, C.P. South African Journal of Science, 33,127.