

THE WORK GOES ON

We should remember it only took 13.8 billion years from the "Big Bang" to where we find ourselves today and the changes just keep keeping on.

Keep in mind the restoration of the Great Melbourne Telescope (G.M.T.) since the "Big Blaze" to now, has only been a few decades.

It is no mean task restoring the G.M.T. when there are no plans or drawings but lots of missing parts. It makes the work rather challenging.

Without the team of volunteers developing engineering drawings from photos, the volunteers in the workshop producing some of the missing parts and cleaning new castings and the optical experts, the G.M.T. would be lost to the people of Victoria and the astronomical community. All this work takes place under the watchful eye and advice of the Museum staff. M. V. rightly,

has strict protocols relating to restoration work and as someone quite famous, once said (or something like this) "That the MV does not play dice". The work still progresses with some volunteers having spent 10 years of their considerable expertise and dedication.

The work could not take place without generous financial support of our donors.

The next few years will be critical to the completion of the G.M.T., the ordering of the new mirrors, the machining

of some of the larger telescope parts and the looming 150 year celebration.

The volunteers may not be getting any younger but their dedication is unflinching.
(Bob Crosthwaite)



CONNECTIONS BEYOND THE STARS *by Matilda Vaughan*

The volunteers have been busy in our workshop with all the newly cast replicas for parts that are missing from the telescope. They've been machining faces, drilling holes and generally cleaning up the parts and these tasks made possible by generous donations.

In 2012 Jack McCrohan (1922 – 2012) bequeathed his entire estate to the Australian Red Cross. In 2013 Museum Victoria was one of the public institutions invited by the Australian Red Cross to select objects from his estate for either its Collection or programs.

Engineering Curator, Matilda Vaughan, selected two of his workshop machines (M.T.I. Qualos Lathe, Model 1236B and a M.T.I. Qualos Milling & Drilling Machine, Model RF-30), as well as many other tools and associated fixtures, which have found a new life, fulfilling a prominent role in the restoration workshop of the G.M.T.

It was unknown at the time of the acquisition that, despite the clue of a dusty telescope housed in his garage, in addition to his many varied interests, including theatre and cinematography, Mr McCrohan was also a keen amateur astronomer.

His personal archive has revealed a carefully staged photographic self portrait of him, circa 1960, observing through his telescope in his suburban Melbourne backyard; his fascination with objects in the sky seems to have begun by the mid-1950s.

An amateur photographer as well, this colour image was taken by Mr McCrohan by remote. There's a real possibility that Mr McCrohan would've loved to have looked through a restored Great Melbourne Telescope.

Finding an unexpected connection like this is a delightful reminder that restoration projects can uncover stories beyond the object itself.

ASV volunteers, Barry Adcock and Steve Pattie turning a screw thread on Mr McCrohan's lathe Image Source:
Museums Victoria, GMT Archive



The G.M.T Eye Pieces by Barry Adcock



Fig. 1

The Great Melbourne Telescope came equipped with a set of very large eyepieces.

We have performed a lot of measurements and analyses on the eyepieces and we are now in a position to emulate a set for use at public demonstrations.

The GMT has a primary mirror 48 inches (1219 mm) in diameter. Assuming the dark adapted human eye has a pupil diameter of 6 mm the lowest power (richest field magnification) is approximately 200x. With an f/ratio of 41.6, the effective focal length of the Cassegrainian configuration is 50650 mm. the focal length of the eyepiece to achieve a magnification of 200 is 50650/200 or ~253 mm. To cover a field of only 15 arcminutes the diameter of the field lens must be 220 mm. Figure 1

shows the box of seven eyepieces giving magnifications from 230 to 800. Figure 2 shows the lowest power eyepiece with a pen and 6

inch ruler as a comparison.

We have carefully measured each eyepiece and made engineering drawings of each. We have made optical measure-

ments to determine the type of glass, its refractive index and dispersion and the radii of curvature and focal length of each element.

We have analysed the results mathematically and using a ray tracing program to predict their performance.

The eyepieces are all of the Huygenian design as shown in figure 3 where some relevant

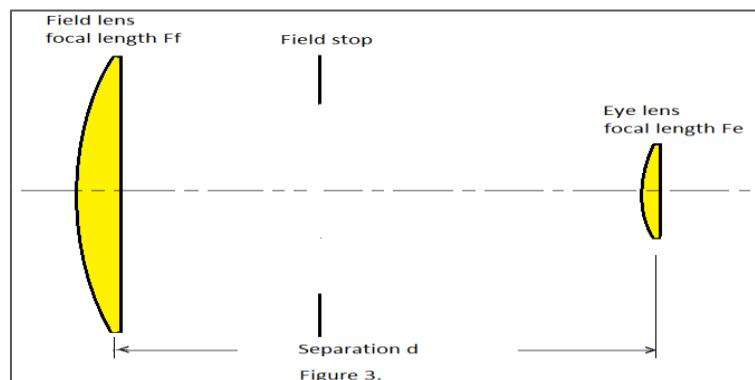
are defined. To minimize lateral chromatic aberration it is required that $Ff + Fe = 2d$

The formula is usually written as a set of

ratios $Ff : d : Fe$. All the GMT eyepieces are made to the ratios 3 : 2 : 1. This configuration also leads to a large eye relief.



Fig. 2





A few of the "Hard Workers" at lunch !!

G.M.T. Team Welcomes The New Project Manager Simon Brink



I am really excited to have joined the Great Melbourne Telescope restoration project as the telescope is such an iconic piece of our scientific and engineering history.

Seeing it returned to the Melbourne Observatory and available for supervised public viewing will certainly provide a wonderful opportunity to pass on stories of our astronomical heritage to future generations.

My background is in engineering and project management, focusing on design and delivery of a wide range of community projects, most recently in local government for Manningham Council. Hopefully I can really assist the project by removing obstacles and best allowing the fantastic team of ASV volunteers to continue with the ongoing restoration work.

I'm particularly excited to be involved with the Great Melbourne Telescope restoration project as, when it was reincarnated at Stromlo, it was apparently the first to identify significant evidence of a form of dark matter. I'm actively involved with ongoing research into emerging energy technologies that relate directly to dark matter. We now have a really good understanding of what dark matter most probably is – it's a contracted form of hydrogen. We know why it doesn't emit any radiation, so is "dark". We even know how to produce it. My specialty is photographing dark matter formation halos and I've also got a couple of alloy samples with really interesting properties made by loading metals with dark matter.

Hopefully we can get back to searching for dark matter with the Great Melbourne Telescope in the not too distant future!!!



THE GMT IN ACTION 1869

by Jenny Andropoulos

In 2014 I completed my PhD on Astronomical Publications of Melbourne Observatory. As part of this work I examined all I could find of the published observations made at the Observatory, including those of the Great Melbourne Telescope (GMT). I joined the GMT restoration team in 2016. My first task in the team was to research and catalogue the historical observations made with the GMT.

In the earlier stages of my studies, I searched through old newspapers on microfilm at the State Library of Victoria. Since then, these newspapers have been digitized and are available for viewing on the internet via Trove, a marvelous free service of the National Library of Australia. I also searched through scientific journals and reports of the Board of Visitors of Melbourne Observatory. In my catalogues I included the nebulae from the 1885 book published under the direction of Robert Ellery: *Observations of the Southern Nebulae: made with the Great Melbourne Telescope from 1869 to 1885*. The GMT was established primarily for repeat observations of southern nebulae that had been detected by Herschel in the years 1834-38 at the Cape of Good Hope. Virtually all of these observations were recorded as drawings and sketches (Figures 1 and 2) of the nebulae and their surrounding stars.

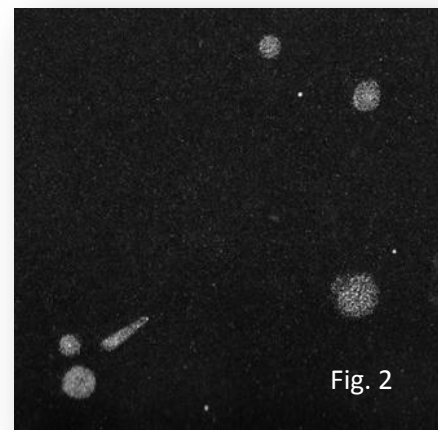


Figure 1: Drawing of eta Carinae and its nebula made by Farie MacGeorge and published in the Transactions and Proceedings of the Royal Society of Victoria.

Figure 2: Sketch of the group NGC 1950, 1958, 1959, 1969, 1971 and 1972 by Joseph Turner, published in Ellery's book of nebulae

The motive for reobservation was the possibility of finding distinct changes in nebular detail, which would indicate that the nebulae were all situated within our galaxy, and that our galaxy was the observable universe. It was to be nearly fifty years on before it was established that many of the nebulae were themselves galaxies at incomprehensibly large distances. That finding depended on a much higher capability in photography. The design of the GMT had been optimised for medium to high power visual use well before the introduction of routine astronomical photography. This was why the GMT needed a major rebuild to make it useful for photography when it was bought by the Commonwealth for Mt Stromlo Observatory in 1945. Observations made with the GMT at Melbourne also included stars: double stars and star systems, clusters of stars, searches for companions of stars, measurements of double stars, mapping of stars in nebulae, micrometric measures of star positions for detailed star charts and spectroscopic studies of stars. Observations and drawings were made of the physical appearance of planets (Figures 3 and 4) as were notes of searches for new satellites and micrometric measures of known satellites.

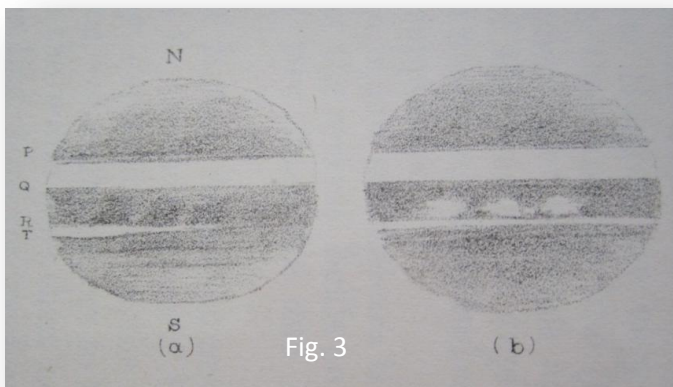


Figure 3: Drawings of Jupiter made by Albert Le Sueur in 1869, showing the zones (Transactions and Proceedings of the Royal Society of Victoria).

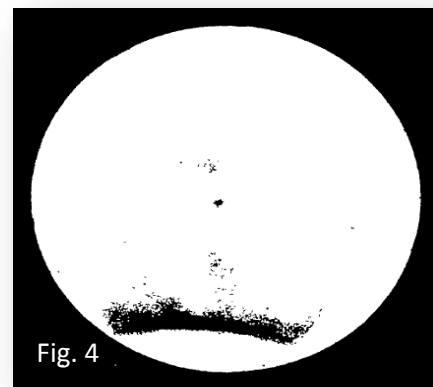


Figure 4: Sketch of Mars by Pietro Baracchi on 26 May 1894, showing the South Polar Cap published in the first volume of The Astrophysical Journal.

Observations of the moon included references to Earthshine and the lunar surface: maria, craters, and mountains. Observations were made with a view to revising the lunar maps of the British Association Committee.

Observations of the occultation of stars by the moon were made in 1874 and 1875 and the occultation of 64 Aquarii by Jupiter on 14 September 1879. Conjunctions were observed in 1875 and 1876. Figure 5 shows the conjunction of Mars and Saturn of 30 June 1879.

Comets were observed and sketched and differential measures to stars were made to assist accurate determination of comet positions.

In turn, this allowed comet orbit determination to be more precise

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Removal Of The Aluminum Coating On The Primary Mirror

by **Alice Cannon** Manager, Integrated Collection Processes Strategic Collection Management Museums Victoria

Barry Adcock, Barry Clark and myself, used mild sodium hydroxide to remove the aluminium coating on the mirror, using cotton rags to move small amounts across the surface.

Even mild solutions of sodium hydroxide are hazardous (to your eyes especially), so we moved the mirror to the Conservation lab to be close to a water supply and the emergency shower.

Carefully lifting the mirror from its protective case

We consulted the safety data sheet for sodium hydroxide and prepared a safe work method statement (SWMS). Everyone working on the mirror wore covered shoes, a lab coat, long sleeves, nitrile gloves and safety glasses, to protect our skin and eyes.

Hydrogen gas is produced by the reaction of sodium hydroxide and aluminium, but only small quantities were expected as the aluminium layer was so thin—we turned on the fume extraction units in the lab to help air flow, just in case, and had half-face respirators on hand.

After the alkali had done its work (watching the coating disappear was like watching a frozen lake melting, revealing the deep water below the ice) we neutralised it with mild hydrochloric acid, then rinsed the mirror with plain water.

Removing the coating in the Conservation lab





1

Matthew Churchward



2

Steve Pattie, Frank Marian & Matthew Churchward



3

Des Lang & team



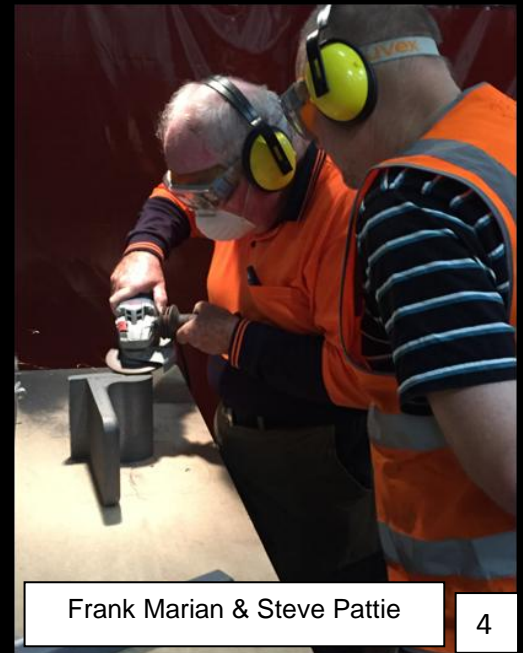
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5

Tom Miller

- 1 Checking
2. Reviewing calculations on the eye pieces
3. Former for new Lattice tube
4. Part of "The beast"
5. Riveting boiler tube assembly



1. Removing the saddle which holds the boiler tube

2. Inspection

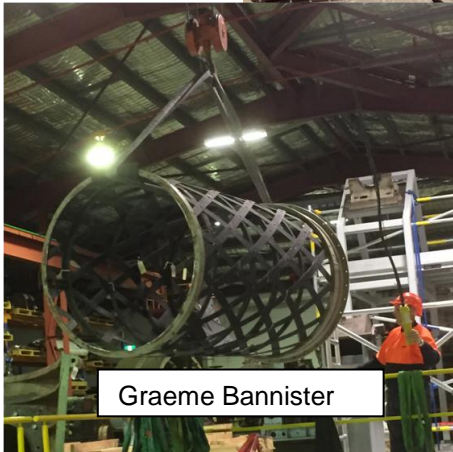
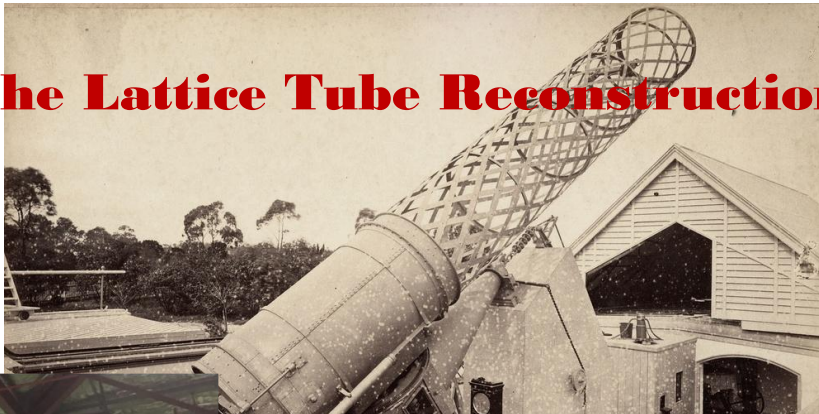
3. Final inspection of Boiler tube

4. Cleaning up one of the new castings

5. Grinding of rivets

6. Communicating progress to interested parties

The Lattice Tube Reconstruction



1



2



3



4

1. The original lattice Tube
2. Removing the old rivets
3. Making new rivets
4. The new rivets
5. The new lattice work



5



GMT IN ACTION 1869Continued from page 6



Figure 5



Figure 6

Figure 5: Diagram made by Joseph Turner of the conjunction of Mars and Saturn on 30 June 1879. There is an error on the diagram: Mars is never seen from Earth with the terminator concave as shown (*Monthly Notices of the Royal Astronomical Society*).

Figure 6: 1870s photograph of the moon taken by Joseph Turner and published in *The Australasian* on 13 April 1895.

Observations of asteroids were limited to the observations of Flora during October and November 1873. Those were made in conjunction with other European observations to be used in determining the parallax of the asteroid,

Astronomical photography was in its infancy when the GMT first reached Melbourne in 1869. Within a few years, fine photographs of the moon (Figure 6) taken with the GMT were circulating to acclaim around the world. In the following decade, some success was achieved in photographing comets (Figures 7 and 8), nebulae and stars.

Figure 7: Photograph of Comet C/1882 R1-A taken in 1882 and published in *The Australasian* on 2 March 1907. This photograph was taken the year after the first successful photograph of a comet, C/1881 K1, by Jules Janssen.

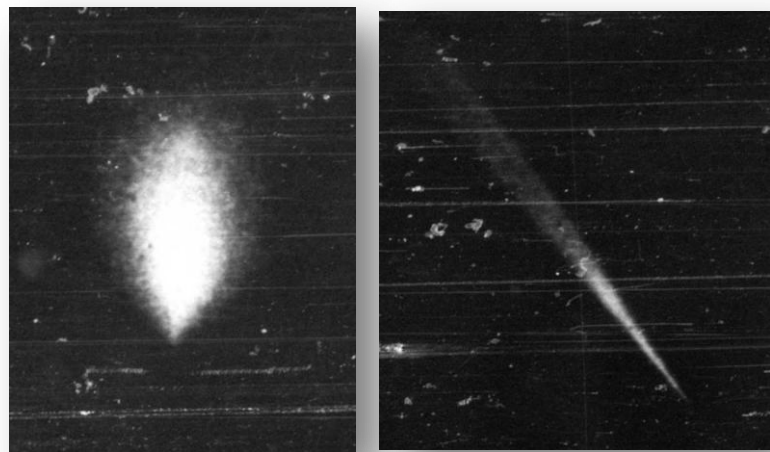


Figure 8: Photograph of Comet C/1882 R1-A taken at perihelion and published in *The Australasian* on 2 March 1907.

There were attempts to take photographs of planets but they failed because the photographic plates of the time were insufficiently sensitive. An attempt to use the GMT to photograph the transit of Venus in 1874 also failed, this time apparently because the sun was much too bright for the

conventional shutter used! Preparations for taking photographs of the total eclipse of the moon of 22 December 1880 were made but were prevented by weather.

Spectroscopic observations were carried out on nebulae, moon, stars, planets (Figure 9) and an aurora. These included the first-ever spectral observation of an extragalactic nebula.

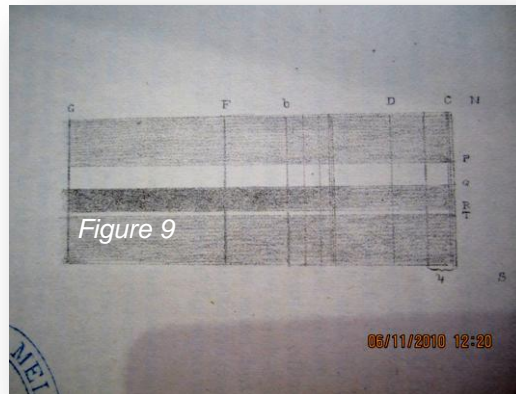


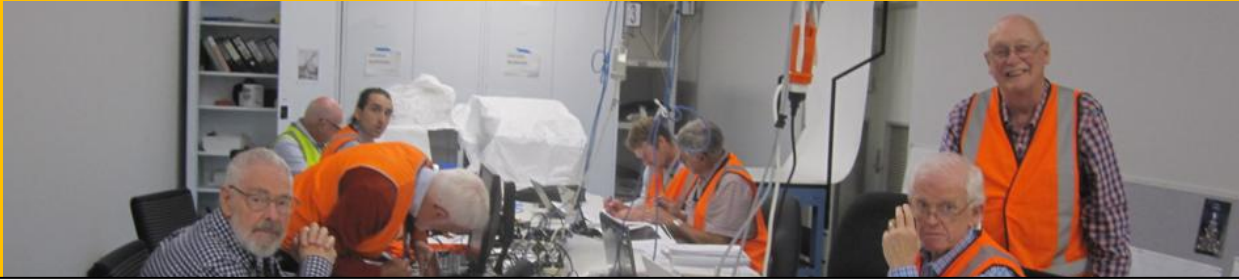
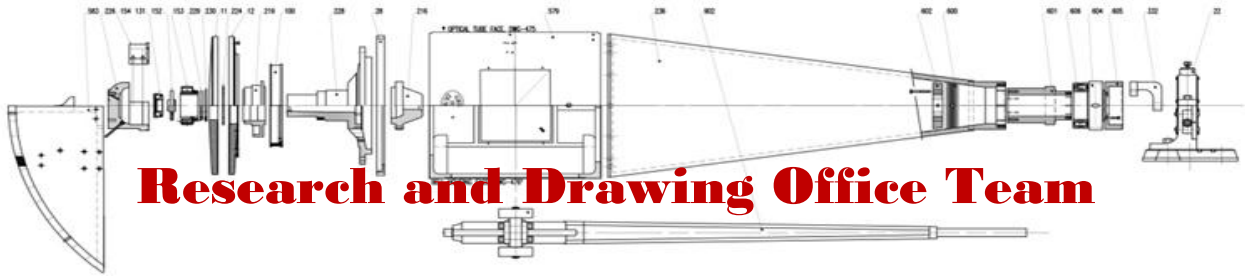
Figure 9: Spectrum of Jupiter drawn by Albert Le Sueur (Royal Society of Victoria).

Many of the observations made with the GMT still exist but remain unpublished. Most of these reside at the National Archives in Canberra. There is also unpublished material at Museum Victoria (Figures 10 and 11) and in private hands. The cataloguing of all the unpublished material remains a task that is dauntingly large but does need to be done.



Fig. 10: Unpublished photograph of the Orion Nebula, taken by Joseph Turner on 26 February 1883, with an exposure of 4 minutes

Fig. 11: Unpublished photograph of the kappa Crucis Cluster, named the 'Jewel Box', in the constellation of Crux. Photograph taken by Joseph Turner on March 3 1883, with an exposure of 5 minutes



Barry Clark, Ken Woolhouse, Barry Adcock, Chet Yilmaz, Simon Brink, Mal Poulton, Barry Cleland, Campbell Johns



Bryan Mooney



Barry Clark



Ken Woolhouse



Barry Adcock



Lunch



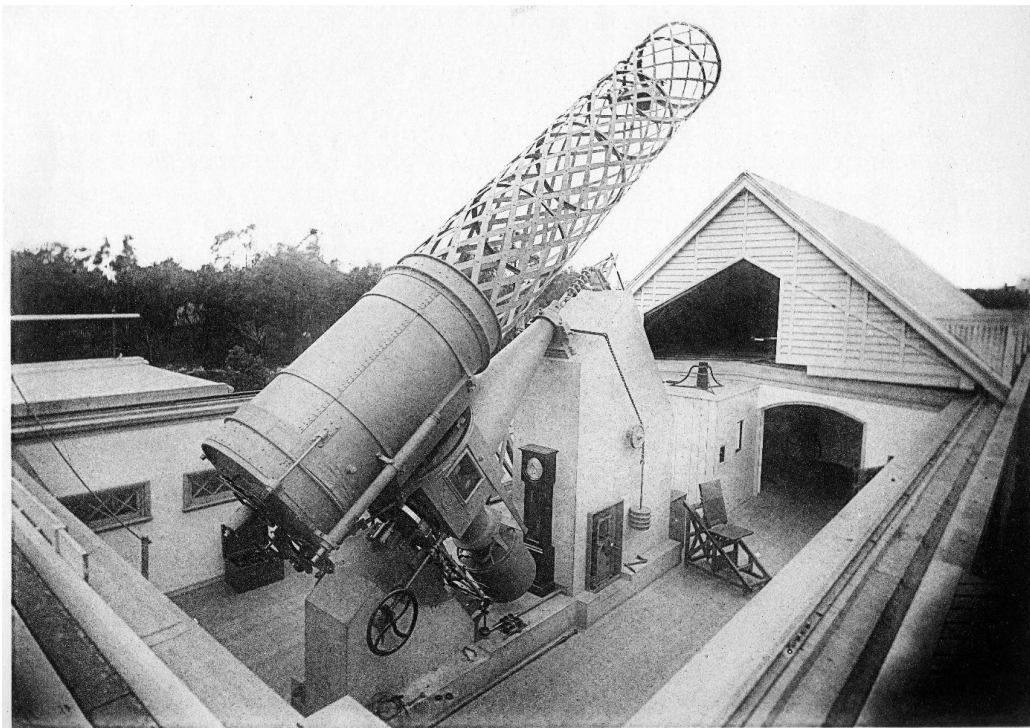
Hard at Work

THE GREAT MELBOURNE TELESCOPE HOUSE

by Barry Clark

HERITAGE MATTERS

The Great Melbourne Telescope House (GMT House) is one of several surviving original 19th century buildings on the Observatory Site. The Site and its heritage assets are included as VHR1087 in the Victorian Heritage Register. At the time (1999) when the entry was first made, it was not realised that GMT House is probably the world's first full-size building with a movable steel-framed roof. As such, it is the archetype of all of the current sports stadiums that have steel roofs deployable on wheels or rollers. This would appear to increase its heritage importance substantially. The heritage importance of the GMT itself is already accepted as very high. The recombined telescope and building will undoubtedly have a heritage importance exceeding the sum of the individual ratings and would appear to be a heritage treasure of world importance. For this reason, unusually careful restoration of GMT House is just as essential as has already been consistently applied in the GMT reconstruction to date. The Australia ICOMOS Burra Charter (2013), a widely accepted guide to the conservation of heritage objects and places, sets minimum standards to be achieved or exceeded. MV has its own rules that are in some cases stricter than is required by the Burra Charter; where justified, the MV rules will take precedence. If the processes and outcomes meet MV rules, compliance with the Burra Charter is guaranteed.



DETAILS OF GMT HOUSE AND TELESCOPE

Figure 1. The GMT in its Chamber with the Roll-off Roof open, no later than 1885. The camera was aimed towards the south-east. Above the mid-left of the picture, note the south-east end of the Semi-circular Platform and its outer side safety rail. The GMT's driving clock is not the longcase clock at the north face of the Main (south) Pier but is close by within the pier, low down on its west side. The apparently Z-shaped item on the step immediately south of the driving clock is the crank handle used to wind the driving clock. It is now missing but the crank handle for the rolling roof mechanism is still in place inside the far end of the roof and provides a model for the lost item. The dormers covering the roof wheels are shown clad in corrugated iron. The present dormers look similar, and are thus a reliable guide to what their appearance should be when all of the cladding of the Roll-off Roof has to

be renewed. Note also the continuation of the timber floor through the archway and into the Polishing Room. Processing of the view into the archway in this and similar images shows the MGPM and jib crane in the position indicated in Figure 2. (Image scanned from Ellery (1885))

Part of the Polishing Room can be seen through the archway in Figure 1. The MGPM is not discernable in this image but in other photographs of the time it can be seen partly hidden by the brick wall east (left) of the archway. The large spoked wheel that is just visible through the archway is probably part of the manually powered jib crane used to lift the primary mirror cell and mirror between a three-legged trolley and the MGPM. Earlier records suggest that there were rails (perhaps timber?) on the floor for the trolley. They would have passed under the observing chair if they ever existed but this and all other known photographs like it show no trace of them. The original timber floor to the west of the GMT piers in the Chamber is still intact and again shows no signs of the presence or former presence of rails.

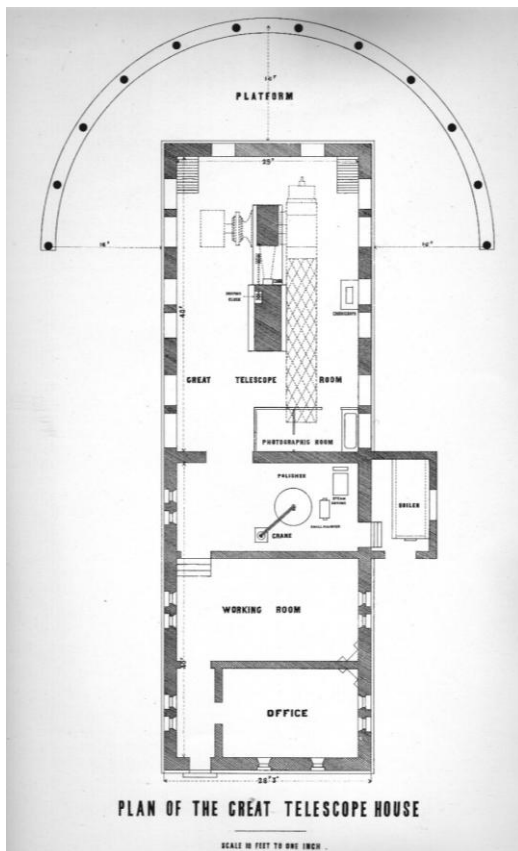


Figure 2. Plan of GMT House as originally constructed, with true north at the top. The boiler room currently has double outward opening doors at its east side. Fireplaces are shown in adjacent corners of the Working Room and Office. The common chimney (see Figure 3) was constructed to be clear of the rolling roof and fortunately it still exists. Note the steps required to access the raised floor of the Polishing Room and Chamber. (Image scanned from Ellery (1885))

Figure 3. GMT House with the Roll-Off Roof open, seen north of north-west from the Main Building before 1885. The north gable end of the Roll-off Roof blocks part of the sky from direct view by the telescope but this is all circumpolar sky and is consequently visible at other times of the night or in other months of the year. Note the dual chimney for fireplaces and the smaller black chimney above the Boiler Room. A triangular frame above and beyond that chimney is a ladder that is movable on rails around the Semicircular Platform. Part of the Platform and more of its outer safety rail is visible. The telegraph lines in the foreground indicate the volume of telegraphic traffic carried for time-signalling, clock time-correction, weather reports and general messages. Note the absence of high trees in the vicinity. The grass appears to be unmowed. There is no walking track let alone a road like the present one between the west side of the Main Building and the east side of GMT House. (Image scanned from Ellery (1885))

Spot the **SEVEN** differences (Answer in next edition of Phoenix)

Original Image source purchased by MV, for GMT project from National Library Australia

