November 2023
Bob Crosthwaite

The Great Melbourne TELESCOPE

Phoenix
Astronomical Society of Victoria (A.I.N. A0002118S)

# THE GREAT MELBOURNE TELESCOPE GEARS UP FOR THE NEXT STAGE

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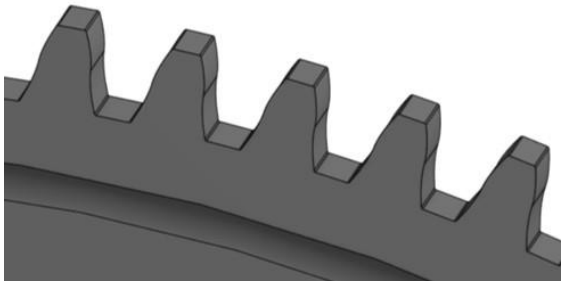
# Replicating the Original Grubb Gears on the Great Melbourne Telescope

By Allan Davies (29th, June 2023)

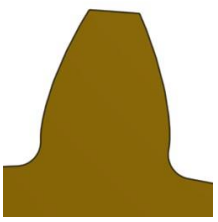
The beginnings of replicating the gear teeth on the Great Melbourne Telescope all began whilst modelling a pair of bevel gears for the Polar Axis Movement Coarse Controls. These were originally modelled using current involute tooth-profiles which are typical in today's world. After discussions and various revisions, it was apparent that the involute tooth profile was not what was seen in the historical photos of the Great Melbourne Telescope.

Knowing that the surviving gears on the Great Melbourne Telescope were of an older cycloidal tooth profile, this was researched further. Various literature from the latter half of the 1800s was consulted and various implementations of the cycloidal tooth profile were presented for consideration.

The current cycloidal tooth profile implementation was arrived at after taking numerous meticulous measurements and observations on the original surviving ring gear that is mounted on the cube on the Great Melbourne Telescope. All the Great Melbourne Telescope's gears now have been designed with these more authentic gear teeth that bear a very close resemblance to the historical photographs and surviving gears and keeps the Great Melbourne Telescope Restoration as true as possible to its original design.



Modeled Cycloidal tooth profile



involute tooth-profile

Original Grubb cycloidal tooth profile Ring Gear

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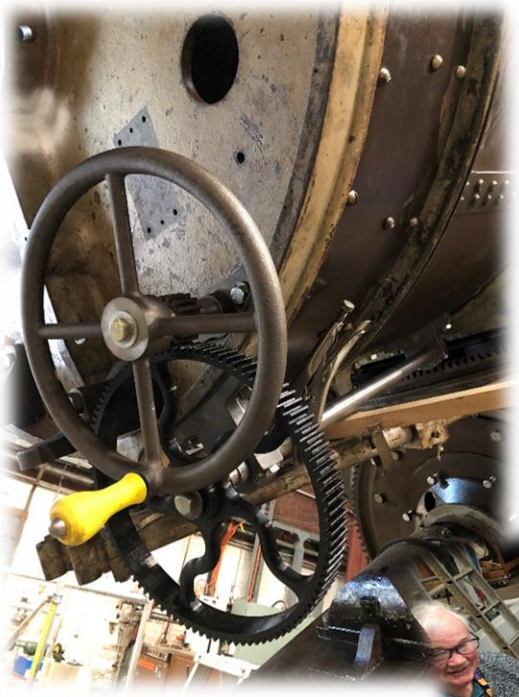
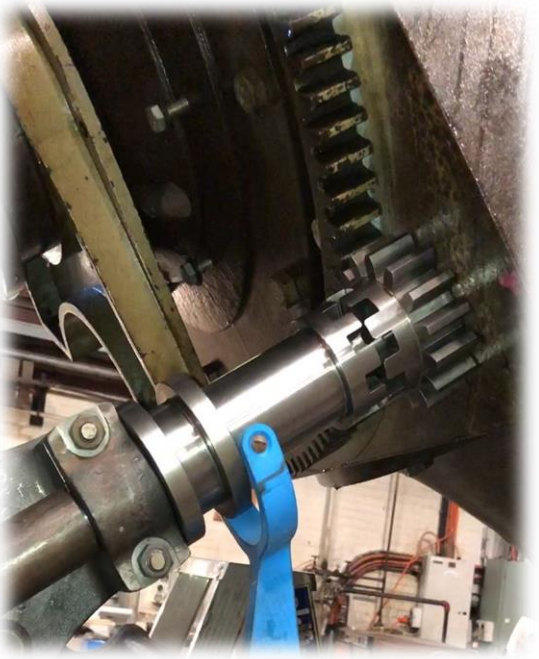
# The Gears







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# A Trip Down Memory Lane

**Material for the articles below, was sourced from:**
**"Victorian Telescope Makers"**
**'The Lives and Letters from Thomas and Howard Grubb.'**
**Ian Glass (1997)**

Robert Ellery

Matters in Melbourne were not helped by local carpers who went so far as to question the wisdom of the whole project. A lengthy and ill-informed debate took place at the Royal Society of Victoria which was printed in *The Illustrated Australian News* and later in the *Astronomical Register* (Anon 1870) in London. This criticism, lacking a reasonable basis, was easily dealt with. More seriously for the project, Le Sueur decided to resign his post in 1870 and thus first-hand experience of figuring and polishing techniques was lost to the Observatory. However, mirror A was repolished together with the secondaries before his departure and was shortly afterwards put back in the telescope. The 'ace of clubs' images were found to have been the result of some pinching of the speculum and did not reappear.

The telescope was used mainly for visual observations of nebulae. Some photography was undertaken in the early 1870s, but this promising work was not followed up. Part of the reason appears to have been wind-shaking, caused by the lack of a dome to shield the instrument. A volume of *Observations of the Southern Nebulae made with the Great Melbourne Telescope* was published, with difficulty, in 1885 (Ellery 1885).

the bearings which defined the exact positions of the axes. For the right ascension axis, a torque of 5 lbs at 20 feet radius was required, while for the declination axis, $12\frac{1}{2}$ lbs at 20 feet were needed. 'Still one man can raise the telescope from the horizon to the zenith in 20 seconds. In reversing it from one side of the pier to the other, two men are necessary for quick work, as it must be moved in [declination] as well as [right ascension]. They do it in 45 seconds.' The position circles could be read by means of verniers to 1 second of time and 10 seconds of arc. A large and powerful governor-regulated clock of Grubb's usual design provided the R.A. drive. It could be adjusted to give special speeds for following planets and a special set of gears gave a lunar rate. The final right ascension drive was through a sector. 'Extraordinary precautions were taken in cutting the teeth of this sector, which are believed to be as exact as many dividing engines.'

"The weight of the moving parts of this huge telescope is 18,170 lbs., of which the great speculum and its box and support are 3500."

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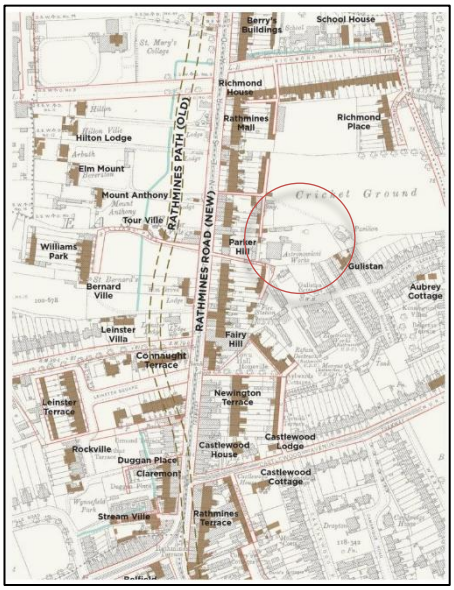
*Image of Rathmines, Dublin in 1860s, where the GMT was manufactured at the Astronomical Works of Thomas and Howard Grubb*




*2023 Photos of Observatory Lane Rathmines Dublin Ireland. (Google Maps)*

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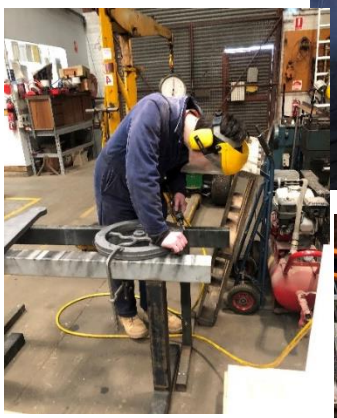
This bit is mine, ALL mine!!
Laurie

A hole in one.
Bob

Will it turn???
Peter, Horatio & Refi

Morning tea in the "Executive" dining room



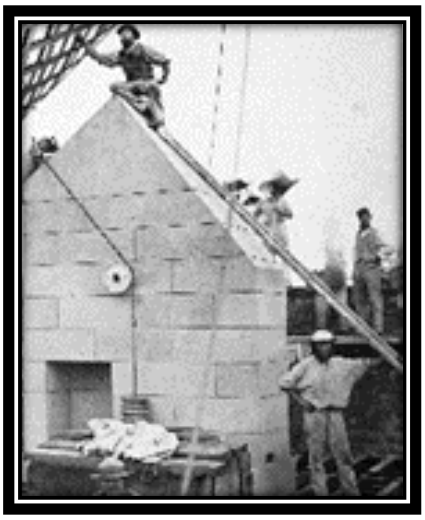
Air chiseling castings
Refi

Now we have it, what do we do with it?
Mal, Des & Bob

Eric
Let's C what we can do with this
Ahh "it's the C bracket"

Alan
Using a vernier caliper for shaping metal???

# CONSTRUCTION OF THE GMT PIERS

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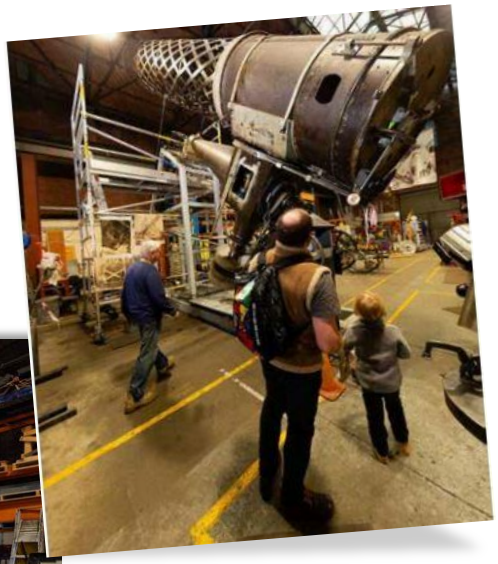
Hi Great Melbourne Telescope Restoration Team,

You are invited to the:
GMTR Volunteers' Family Day
Engineering Workshop
Scienceworks
Thursday 17th August 2023
3:00pm until 4:30pm SHARP



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# END OF 2022 GMT SYMPOSIUM & SOCIAL

Pick a number and watch it spin.
Bob discussing the mock-up primary mirror

**PROGRAM**

2.45pm. Assemble in GMT Public Viewing area.

3.00pm. Presentations on Fabrication & Assembly Progress. (Workshop)

4.15pm. Design Symposium – Part 1 (Conference Room & Online))

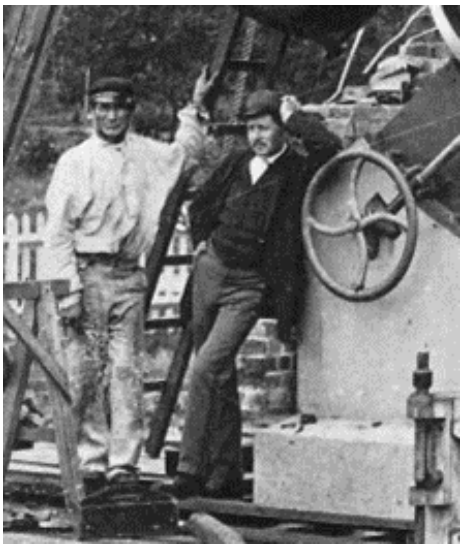
5.15pm. Tea Break

5.30pm. Design Symposium – Part 2 (Conference Room & Online)

6.45pm. Refreshments

7.30pm. Planetarium

We have other talents than just working on the tools.
Mal & Ken serving "Arvo. Tea".



Circa 1869
Worker lad & Dr. Le Sueur

Circa 2022
Worker lad & Dr. Le Sueur
aka. Mal & Bob

# Steve Bentley Donates the Secondary Mirror Cell Microcontroller Prototype to Museum Victoria

On the 5th of July 2023, Steve Bentley officially donated his working prototype of the GMT secondary mirror cell microcontroller. Shown in the photo is Steve handing the prototype over to Simon Brink.
The SMC microcontroller prototype is an electrical equivalent to the system that will be installed on the GMT. The microcontroller monitors the DC power, voltage and current, the air temperature and humidity, the mirror temperature, the mirror cell vibration in 3 axes and controls the mirror cooling fans, the heater and the collimation motors. The prototype is a test bed that will enable the ongoing development and optimisation of the microcontroller software. Future upgrades to the GMT SMC microcontroller can be evaluated on the prototype before being implemented on the actual telescope. The development of the operator's console will also be possible using the prototype.

Steve began work on the prototype in 2020 and version one was constructed during 2021. The restoration team decided the microcontroller should also control the secondary mirror collimation motors; therefore version 2 was constructed to include that feature. Extensive testing of both hardware and software over many months was necessary before the final design assembly could be considered complete.

The primary mirror cell microcontroller prototype was also donated to Museum Victoria earlier in the year.

Written: by Stephen Bentley
Date: 15 August 2023

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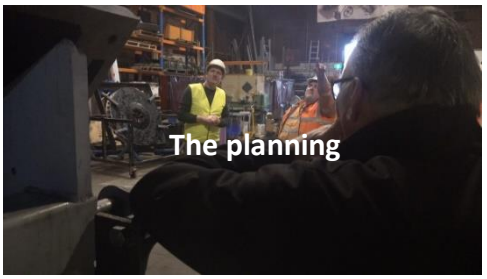
# DISMANTELING AND RE-ASSEMBLING THE GMT

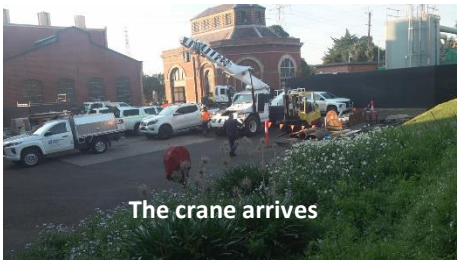
## SEPT. 2023

## WHY???

The main reason we did this was to allow for 3D scanning of the telescope with the polar axis in different positions. This was to check the polar axis alignment.

To accomplish this, it required removing the telescope from its support stand, carrying it out of the workshop by crane, removing the lattice tube, and then returning the cube, boilerplate tube and saddle etc. etc. back in place on the support stand.


The planning


The crane arrives


Mal removes the cradle straps


The crane lifts the GMT

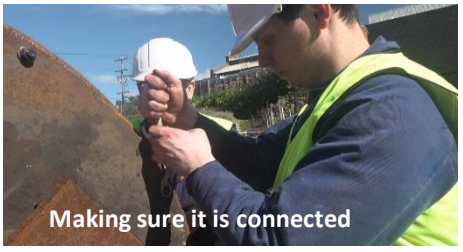

The GMT is moved out into the yard


Des directs the positioning of the lattice tube

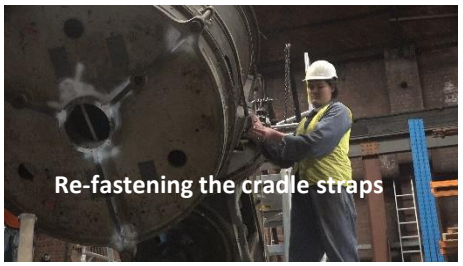

Removing the lattice tube


Counterweight to match the lattice tube


Attaching the counterweight


Making sure it is connected


Re-assembling the cube, boiler-plate tube etc.


Re-fastening the cradle straps


Returning the lattice tube to the workshop

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# THE MONSTER MOVED !!!!


GMT rotated on it's polar axis


GMT rotated to the west side at 90º


GMT in the parked position


Simon, Ryan and Des.
Seeking guidance.

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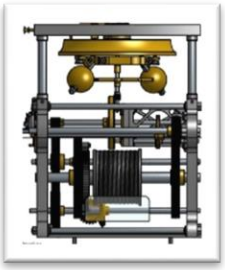

# TICK TOCK, HERE COMES THE CLOCK

## GMT CLOCKWORK DRIVE STARTS TO TAKE SHAPE

Face plate casting

Top plate casting

What have we got here??

Michael with face plates, being sent away for off-site machining.

Governor support frame patterns.

Ratchet wheel

A variety of clockwork drive “bits and pieces”. (Note: large white pattern wheel excluded)

Friction plate casting and pattern

Tom and Oscar with upper bracket

**A collection of Museum Victoria Media Grade Images of the GMT.**
**Photographer Tim Carrafa**

**Simon Brink** (Project Manager)

Watching the GMT coming to life this year as a dynamic moving telescope has been a fantastic culmination of the restoration team efforts. Tireless measurement, design and 3D modelling work over many years was realised, firstly as patterns and individual components, then completed assemblies and finally as systems capable of dynamically moving The Great Irish Lady. Since late 2019, we have worked diligently in her sleepy shadows. Now we must dive for cover as she turns to greet us!!!

Behind the scenes this year has also seen amazing progress in many other areas. The software group is well on the way to realising an operator's control interface. The first of three replica eyepieces have been completed by Barry Adcock, with two more in progress. A maintenance manual is underway, (thanks to John Dardemann and Ian Marshall), with sections written for many assemblies. Mechanical design of the clockwork drive cable system is progressing well. And we now have new 3D designing capabilities within our team!!!

There is still much more to do to achieve completion by mid-2025, ready for full sky testing, so next year will need to be "a big year". The continuation of the great team efforts this year into next year, will hopefully keep us on course for completion and ready for the next phase of "testing and optimisation" in 2025/26.

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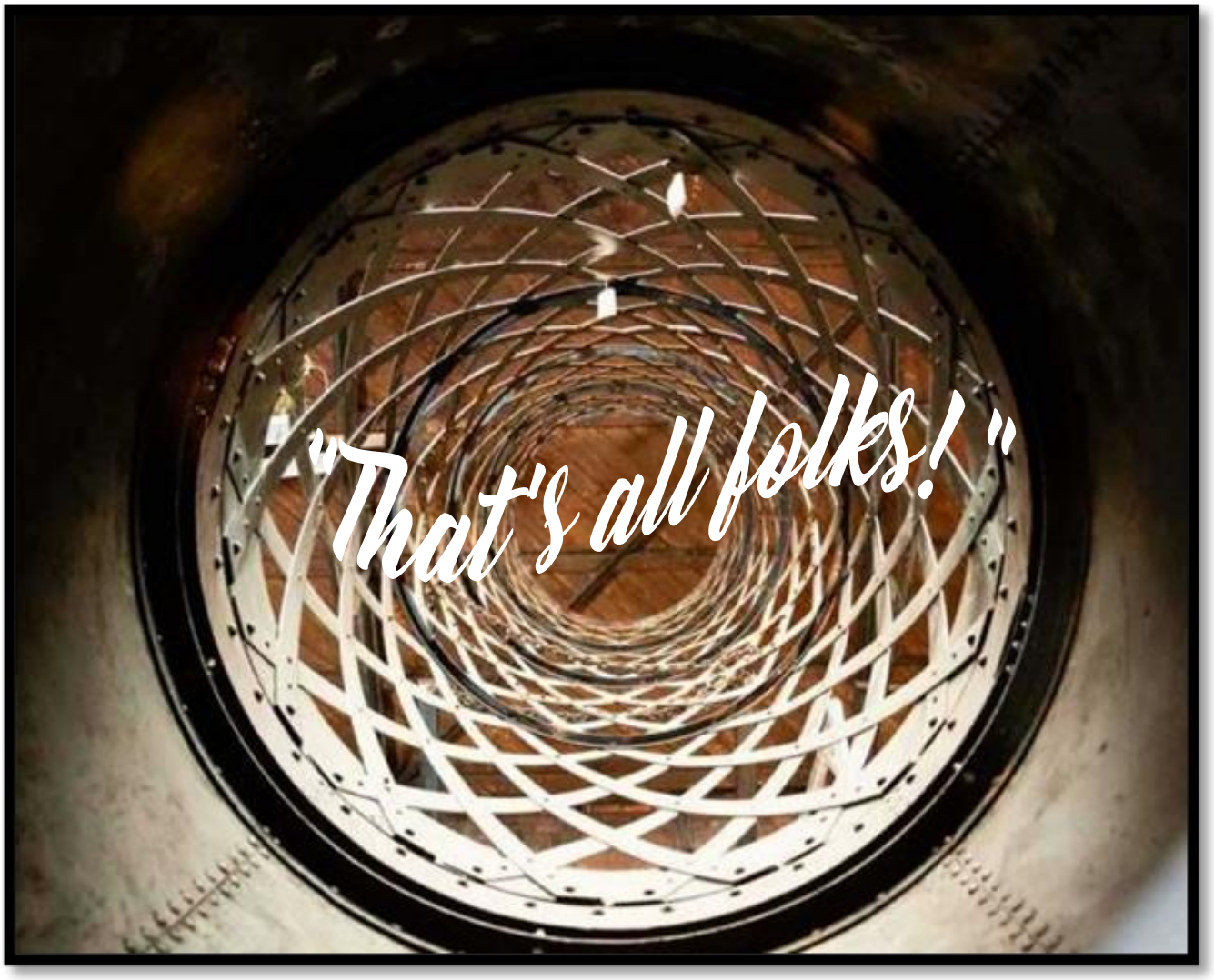
# THE 2023 GMT RESTORATION TEAM MEMBERS

| | | |
|---|---|---|
| Allan Davis | Alan Watson | Ali Khan |
| Amy Zuell | Barry Adcock | Barry Clark |
| Ben Higgins | Bob Crosthwaite | Bryan Mooney |
| David Stare | Des Lang | Dylan Were |
| Eric McCallum | Frank Marian | Hamsini Patabendhige |
| Horatio Yen | Huy Cuong Tran | Ian Marshall |
| Jim Pollock | John Dardemann | Ken Woolhouse |

**"Current and Former Restoration Team Members at the 2023 Volunteer Family Day"**

| | | |
|---|---|---|
| Laurie Goodison | Mal Poulton | Matthew Churchward |
| Navdeep Singh | Nik Lai | Noel Paine |
| Peter Heath | Philip Batistatos | Rafael Cohen |
| Rafia Chowdhury | Ross Bencina | Ryan Nguyen |
| Sara Maric | Simon Brink | Steve Bentley |
| Steve Roberts | Stewart Beveridge | Stuart Higham |
| | Tom Miller | |




**WE WILL BE BACK IN 2024**

# CHEERS