Adventures in telescope building
XLB Scope – Number 2

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Constant Eyepiece Height for Comfortable Viewing (in Newtonian configuration)
Dual configuration possible – Newtonian / Cassegrain

BACKGROUND

I was inspired after attending the 2010 ScopeX !

Amateurs astronomers had achieved wonderful results by their own efforts in so many areas, this revived my interest in making one's own instrument and I decided to break a long fast and build my second telescope.

My first effort was a longish (!?) time ago, when, in my teens I was given a mirror. I constructed the tube and made the tripod and mount from galvanized pipe fittings. I well remember "First Light" – what a disappointment, the mirror wasn't very good at all! Since that time, naked eye astronomy has been my approach – and there is plenty of merit in that.

But I was undoubtedly missing out on lots. The International Year of Astronomy in 2009, the wonderful pictures and text now available on the internet (APOD especially), my new career as a teacher and of course last year's ScopeX all combined – it was time for Scope Number Two.

THE ADVENTURES BEGIN

I began by grinding my own mirror. I wanted to be starting from the very beginning this time. Obtaining the materials was the hardest thing. Eventually after much internet research, I decided to do use a pyrex pie dish idea. Obtaining abrasives was the next challenge and I was fortunate enough to have a connection who sent me a selection of powdered silicon carbide grits from 80 to 400.

The grinding was surprisingly easy and I got down to fine grind without much difficulty. Now what? It was time for the pitch lap, polishing and figuring. Another hurdle appeared - where to obtain the pitch from? I could have bought it from the American suppliers and shipped it in – and maybe I still will, but I wanted to be as local as possible, so eventually I bought 15kg (the smallest pack) of rock bitumen from a local supplier. My next task is to turn this into a workable pitch, but in the meantime, fate stepped in.

FATE STEPS IN

I was donated no less than four telescope mirrors and numerous smaller items (what luck, can you believe it?!). Suddenly my whole approach had to change. I needed to get these things turned into workable telescopes, especially as I want to use these for astronomy education and outreach.

Part of the donation was the eye/knife/light side of a Foucault tester. So I completed the test setup by building a mirror holder and tested the largest mirror (250mm diameter), which at that stage was uncoated. I found using a Ronchi grating easiest. The mirror looked good, though perhaps it had a slight turned down edge.

So I went on and had the mirror aluminized. This was a very interesting exercise – there is a coater in Pietermaritzburg and he very kindly allowed use of his production facility – the result wasn't 100% perfect, but good enough for trials. I was delighted with the progress.

DESIGNING THE MOUNT

Next it was out with the sketch paper and a few ideas for the mount and stand were drawn in rough. Here were a few of my design parameters...

- Firstly, I wanted a modular and flexible type of construction so that all the mirrors could be used on this mount and frame.
- Secondly, as the big mirror is perforated, I wanted to be able to use the telescope in both Newtonian and Cassegrain configurations.
- Thirdly, viewing comfort was important – I didn't want to have to use ladders, or to bend down lots.
- Fourthly, I wanted the whole thing to be as low-tech as possible – not expensive and within my (limited) capabilities to make.
- Fifthly, I wanted some degree of portability.
- Sixth, this setup was for visual observing only.

The key features of the concept that emerged are...

- Altazimuth movement mounted on a pier. The moving bearings use thread bar and nuts
- The telescope main support is a single length of square tube. (This was scrap I found behind my workshop)
- A mirror box was constructed from 16mm Supawood (MDF)
- The secondary and eyepiece box was also made from 16mm Supawood. The spider came with the donation of mirrors etc and was fitted as is.
- The eyepiece focuser is constructed from plastic plumbing parts
- Modular parts can be dismantled for portability
- The eyepiece lies along the altitude axis – therefore the eyepiece remains at a constant height regardless of where the telescope is pointing. Hence no need for bending or ladders. This makes observing very easy.
- The scope is counterbalanced on the other side of the azimuth axis by an arm with counterweights. The weights were long unused diving belt weights that I melted down and cast into square tube.

REALISATION

Then came the building. See photographs to show the different parts built.

PIER STAND

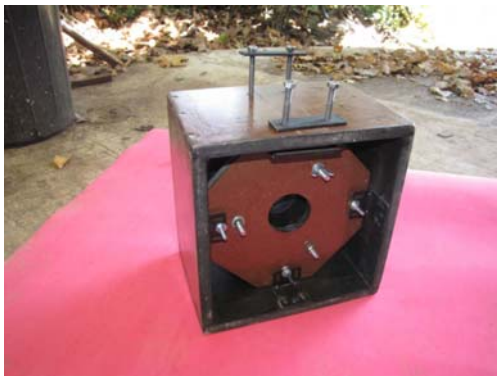
The pier assembled and disassembled.

TWO AXIS ASSEMBLY

The whole assembly fits onto the pier stand. Below is shown detail of the altitude movement – horizontal threaded bar, and the azimuth movement, embedded in the square tube.

MIRROR BOX

Left view shows view from behind revealing adjusting nuts for mirror cell.
Right view shows mirror box from the top.



DIAGONAL BOX

Diagonal box with detail of focuser

COUNTERWEIGHT ARM

TELESCOPE ASSEMBLED

ASSESSMENT

So, how well does it all work?
The scope weighs approximately 50kg…

Mirror and mirror box	9.5 kg
Scope square tube suppor	4.0 kg
Diagonal Box	3.5 kg
Axis assembly and bearing box	5.0 kg
Counterweight arm	19 kg
Pier	8.0 kg

The axis assembly is highly stressed and displays significant amounts of strain. I would definitely redesign this part of the setup for more rigidity next time. That is the main negative.

On the positive side, the scope is very comfortable to use – no bending, no ladders. This makes up for the difficult areas, and indeed further refinements will enhance the viewing experience further still.

THANKS
Huge thanks go to Rogan for the donation of mirrors and other items. Most importantly, mega thanks must go to my wife, Hilary for her support and for allowing me to spend so much time on this project whilst many other things needed doing.

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Appendix 1 - Schedule of Costs (incomplete)

ITEM	USED	PURCHASED	R PER UNIT	RANDS
Mirror		provided		R 0.00
Spider and diagonal		provided		R 0.00
Eyepiece 25mm		provided		R 0.00
Square tube 60*60*2mm	0.8m	1m		
Square tube 50*50*2mm	4.3m	5m		
Square tube 20*20*2mm	3.6m	4m		
Angle iron 30*30mm	0.5	1m		
Flat Bar 25*5mm		1m		
Thread bar 20mm	0.6	1m		
Nuts 20mm		10		
Thread bar 8mm	0.3	1m		
Bolts 8mm - length 16mm		24	R1.00	R24.00
Bolts 8mm – length 30mm		4	R1.50	R 6.00
Bolts 8mm – length 75mm		4		
Nuts 8mm		30		
Washers 8mm		12		
Welding rods - pack 1kg		1	R50.00	R50.00
Casting Resin – tin of 500g		1	R57.00	R57.00
Filler				
Lead – kg		15 kg provided		R 0.00
Supawood 16mm 70cm * 120cm		0.9		
Supawood 6mm 30cm * 1.2cm		0.4		
Plank 20*300*300mm		provided		R 0.00
Black oxide metal paint 1 litre can		1		
Clear Polyurethane Varnish 1 litre can		1		
Solvent – Turps				
Solvent – Thinners				
Brush		1	R15.00	R15.00
Plastic Plumbing Thread reducer		1		
Plastic Plumbing Thread reducer		1		
Time		**lots!!**		