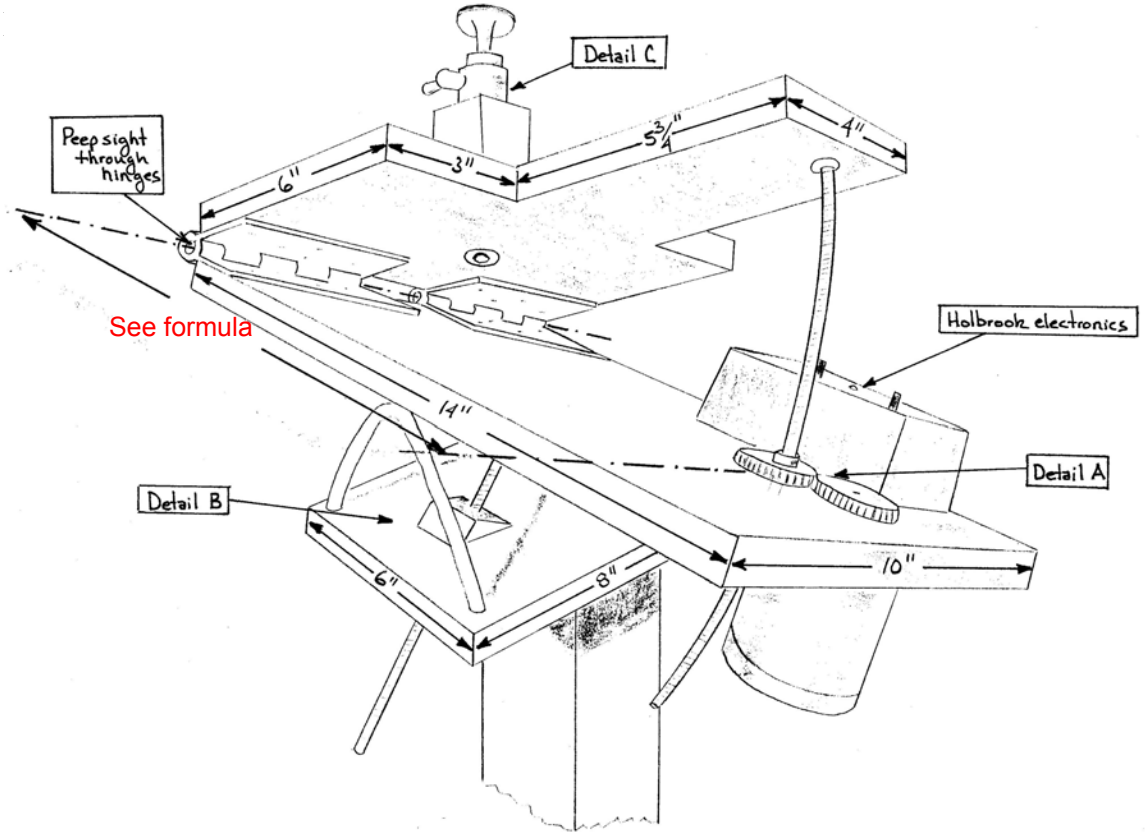
SAC Barndoor Tracker Project – 1989

The accompanying drawings (Electronics 1-7 and Mechanical 1-2) are from the SAC Barndoor Project in 1989. At that time about 15 members gathered in my garage to assemble kits that I had put together for about $75.00 per tracker. Some of the participants quickly completed the project in the subsequent week, and some, well let's say that there are probably some trackers out there that still have not worked correctly.



While the underlying concept is still the same, a lot has been done with barndoor trackers since the 1980s, and there is a wealth of information on the Internet, information that was not available back when we did the SAC project. Any effort to build the tracker shown in the accompanying drawings should be well tempered with a study of recent mechanical design improvements and, especially, variations in electronics. A good place to start is http://home.wanadoo.nl/jhm.vangastel/Astronomy/links.htm (go to the Scotch Mount and Stepper Motor and Circuits sections); from there you can follow links all day long.

Mechanical design

There is nothing really original about this design. Rather it was a compilation of various designs published in *Sky & Telescope* in the 1980s. It is generally described as an offset-motor curved-bolt tracker. The advantage of the curved bolt is that it provides the best tracking accuracy over time. However, you should not assume that the accuracy occurs on

the order of hours. I routinely achieved 15 minute exposures using a 100mm lens on a 35mm reflex camera.

The one feature of this design that I have not seen used too often is the peep sight through the axis of hinges (see isometric drawing). To do this you need to select door hinges with a removable hinge pin. Once the hinges are attached to the two sides of the platform, replace the pins with thin-walled aluminum tubing that you can find in hobby stores. Brass tubing does not work because the fit ends up being too tight; the aluminum tubing has enough give to allow the hinges to move freely after forcing the hinge tubes into place.

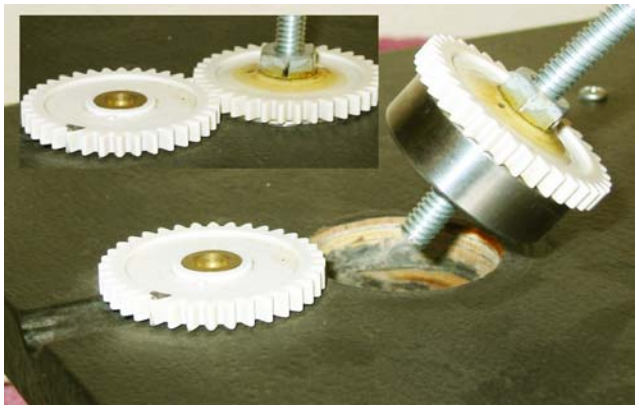
The only critical dimension is the length from the center of the hinge pins to the center of the nut through which the curved bolt passes (R in inches). This distance is a function of the turning speed of the curved bolt nut (n in RPM), the threads per inch (t in TPI) and minutes in a sidereal day (1436.5) – $R=1436.5\ (n/2\pi t)$. The SAC tracker used one RPM and a ¼-inch 20-TPI curved bolt, resulting in a hinge-to-nut distance of 11 7/16 in.

Selecting the stock for the curved bolt and the curved bolt nut is also important. The better the quality of these, the better the tracking accuracy. There is not much to select from in the way of threaded-rod stock (use what you get out of the bin at your hardware store), but when it comes to the nut, select a more expensive stainless steel or brass nut rather than just a generic nut out of the five-cent bin.

For the SAC project we had a jig for bending the threaded rod to just the right curvature, but the jig is long gone. It is actually not too difficult to do this if you bend the rod around something round that is slightly smaller than the desired curvature (which is roughly 12 inches in radius). Originally I used the rim of a spare tire.

The drawings do not give specific specifications for the two gears and the bearing used (see Detail A). You will not build a tracker if you have to buy a specific gear or bearing because these parts can be very expensive. The SAC tracker design actually began by finding a bag of surplus bearings and gears at nominal cost from which enough parts where gleaned to make 15 trackers. So, the advise to you is to start by finding suitable surplus gears and a bearing, and then design around them. The general idea is that the collar of the gear (OD) must slip tightly into the hole in the gear (ID). The curved-bolt nut is then just epoxied to the gear. A second identical gear slips over the shaft of the stepper motor.

Illustration 2. Detail A.



The adjustable elevation for the tracker is accomplished using a straight piece of threaded rod that passes through an angled block. Put a cap nut on the end of the rod that hits the base of the upper platform and a wing nut on the other end of the rod. A short piece of bunge cord helps to hold the elevator base and platform base together with tension (see Detail B).

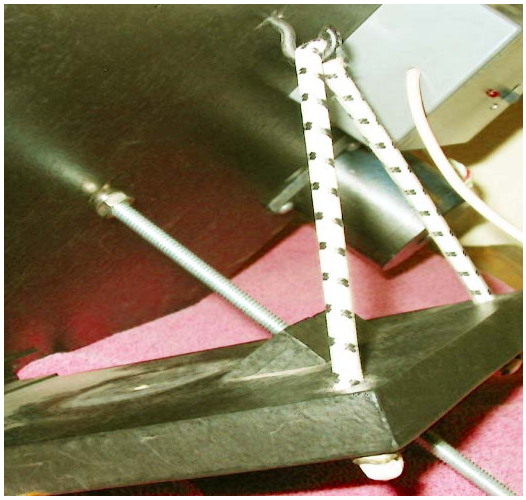


Illustration 3. Detail B.

Placement of the riser and camera swivel mount is best done in the center of the widest portion of the upper platform. However, in this position it may be difficult to look through the camera's viewfinder to align for a given shot. If the camera and lens are light enough, the position of the riser can be moved around. Detail C shows holes drilled for mounting the riser in several locations.

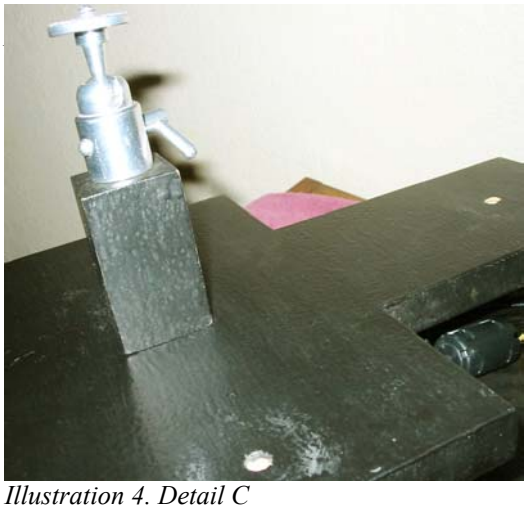


Illustration 4. Detail C

Electronics

The stepper motor electronic used in the SAC barndoor tracker are those of John Holbrook (*Sky & Telescope*, July 1986, p. 80). For the SAC project this circuit was simply laid out to fit into a hobby electronics box that was readily available at the time. With the Holbrook circuit, resistor values are selected based on the stepper motor. If you use the Holbrook circuit, you will need to get a copy of the original article (it is also in the book *Handbook for Star Trackers* but a little searching on the Internet will probably find the details that you need). Here again, you can not afford to build a tracker by specifying a specific stepper motor at the cost of $100 plus. Rather, you go out a find a surplus stepper motor, which is still going to be the most expensive part, and then design around it. In the SAC project we used motor Model TM24K964/965/969/970 from H&R Corp. but purchased from an electronics parts surplus dealer. One change after building the original SAC tracker was to replace the simple resistors with high precision resistors (1%).

Good Luck!

If you pursue building a tracker, I would be happy to communicate with you on my experience or try to recall specifics about this design and the SAC project, if the answers are somewhere in my memory.

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