

Assembly Instructions for the Multi-Dial March 2014

This paper dial was created by the world famous sundial designer and artisan, Tony Moss of Lindisfarne Sundials, UK.

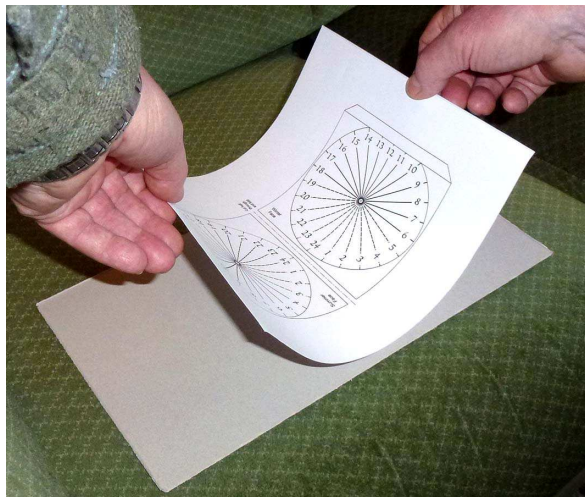
1. Select one of the zip files that includes your latitude (30-40°, 40-50°, or 50-60°). At the bottom of these instructions, download the appropriate zip file. For example if you are in Los Angeles select the 30-40° Multi-Dial.zip; if you live in Montreal, select the 40-50° Multi-Dial.zip; and if you live in Calgary, select the 50-60° Multi-Dial.zip

2. What you will need to assemble your Multi-Dial:

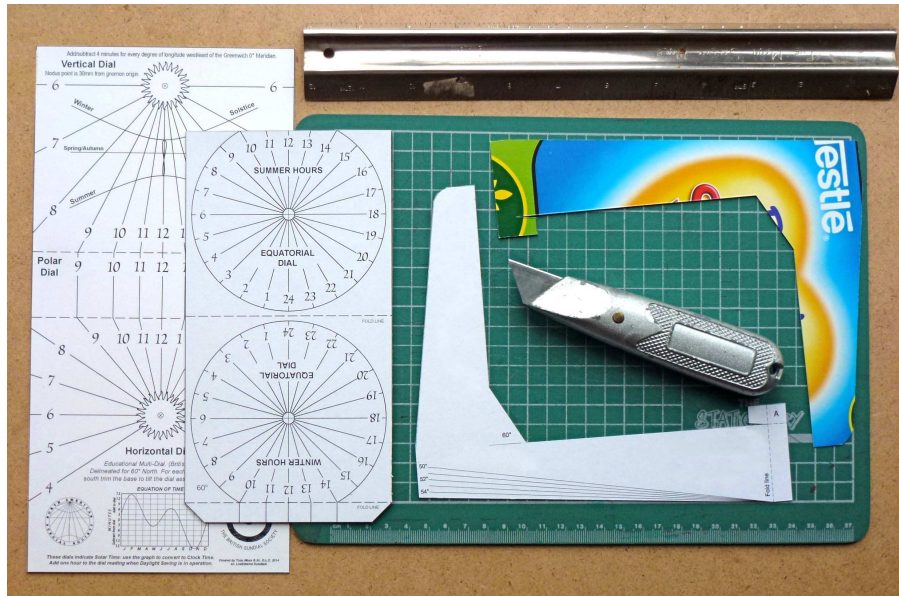
- Some thin cardboard from several large cereal boxes or other dry-goods boxes.
- A glue stick (acid free) for attaching the print-outs to the cardboard. An alternative is to purchase self adhesive sheets from major stationers such as Staples for printing directly onto paper that can be easily adhered to the cardboard. This also avoids shrinkage and wrinkling that may be caused by some glues or adhesives.
- A bottle of white glue (Elmer's or equivalent)
- A bamboo kabob skewer (to become the sundial gnomon)
- A sewing needle (to start holes in the cardboard)
- A 16-penny nail or knitting needle (to enlarge holes in the cardboard)
- From the hardware store, a 2.5mm "O-ring" (that will fit onto the skewer)
- From the hardware store, several paint stir sticks and some rubber bands (to be used as clamps)
- A sharp cutting knife (for example an X-Acto knife or Stanley box-cutting knife)
- A sturdy ruler (to help cut the parts)
- A cutting board (cover with plastic wrap when gluing)
- Some rubber bands and a couple of close pins (for holding things together)

3. Construction is simple, but calls for careful work with a very sharp knife and sturdy ruler. This calls for adult fingers and patient work. Practice on some scrap cardboard until you feel confident of cutting cardboard accurately. Don't rush. And safety is first.

4. Print the files A-D from the zip file. Apply the glue stick to the back of the sheets and drape them onto your cardboard. Make sure the artwork does not overlap on any cardboard folds. You want a nice piece of cardboard backing. Firmly press the paper onto the cardboard. Make sure no glue gets onto the front of the paper ... it makes a mess and can smear the printed artwork.

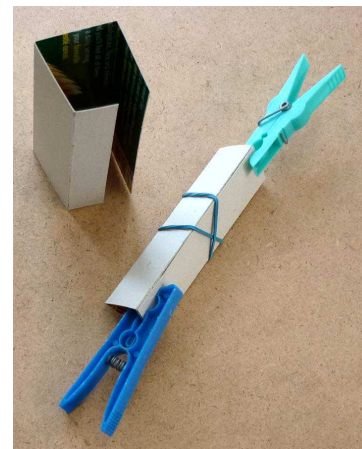


5. Follow the instructions to cut out parts from each of the four paper-cardboard sections. Folds are on the dotted line, but be careful to only make a partial cut ... and where indicated, that partial cut is on the BACK side of the cardboard.

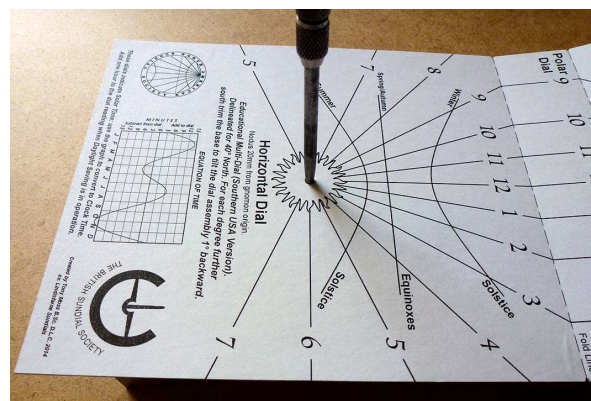


6. From sections C and D, fold the two triangle spacer. Use either the glue stick on the inside of the flap or use white glue, holding the triangle together with rubber bands until it dries.

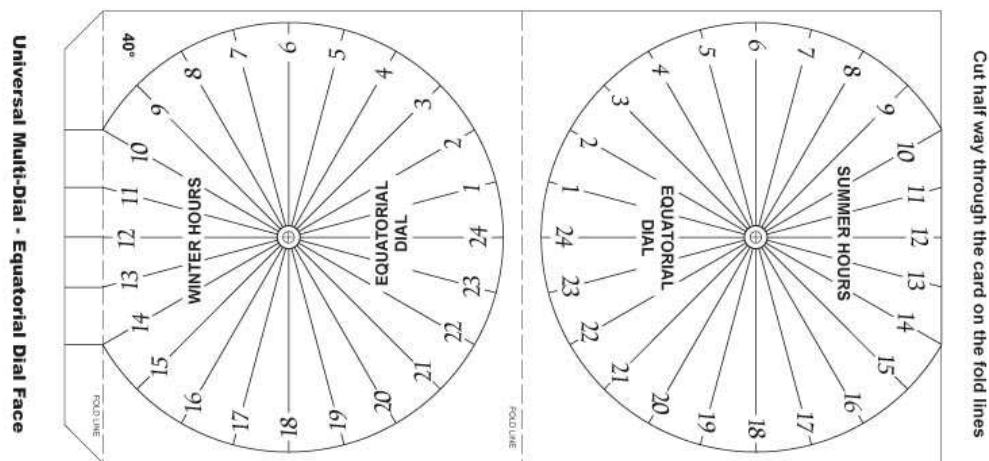
Score the dotted lines with a blunt knife before folding. Some folds are done with the blunt knife score on the back side of the part.



7. From section A, start a hole in the center of the top and bottom sun using a needle. Then carefully enlarge the hole using the nail or knitting needle so that the bamboo skewer just fits through.



8. Score and then fold section B, the equatorial section in half. If the two halves fit together squarely, apply the glue stick to one interior side. Firmly press together and smooth. Start a hole in the center of the circle using a needle or small sharp object. Then carefully enlarge the hole using a nail or knitting needle so that the bamboo skewer just fits through.

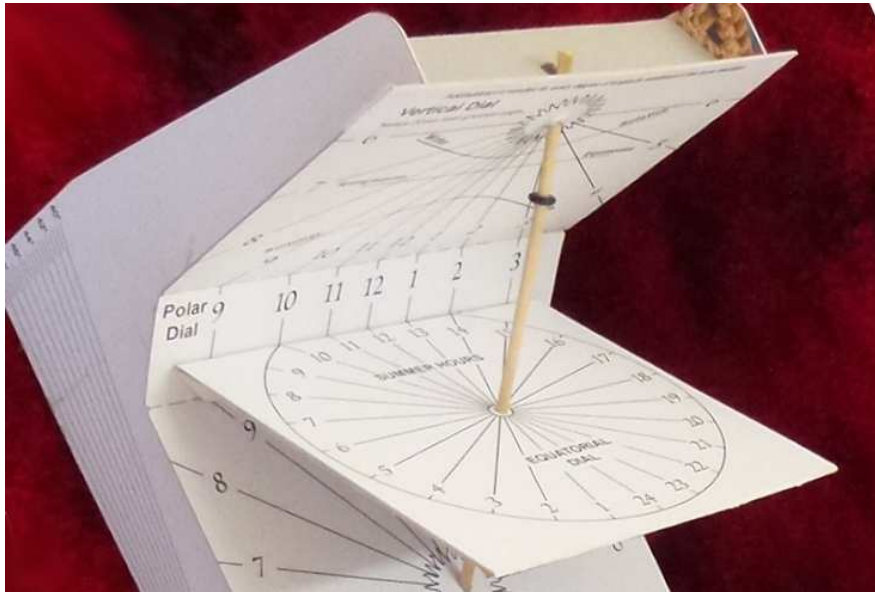


9. Carefully cut out the left and right supports from sections C and D. Along the lower edge, cut on the line that nearest match your latitude. Follow the remaining instructions on the paper-cardboard sections.

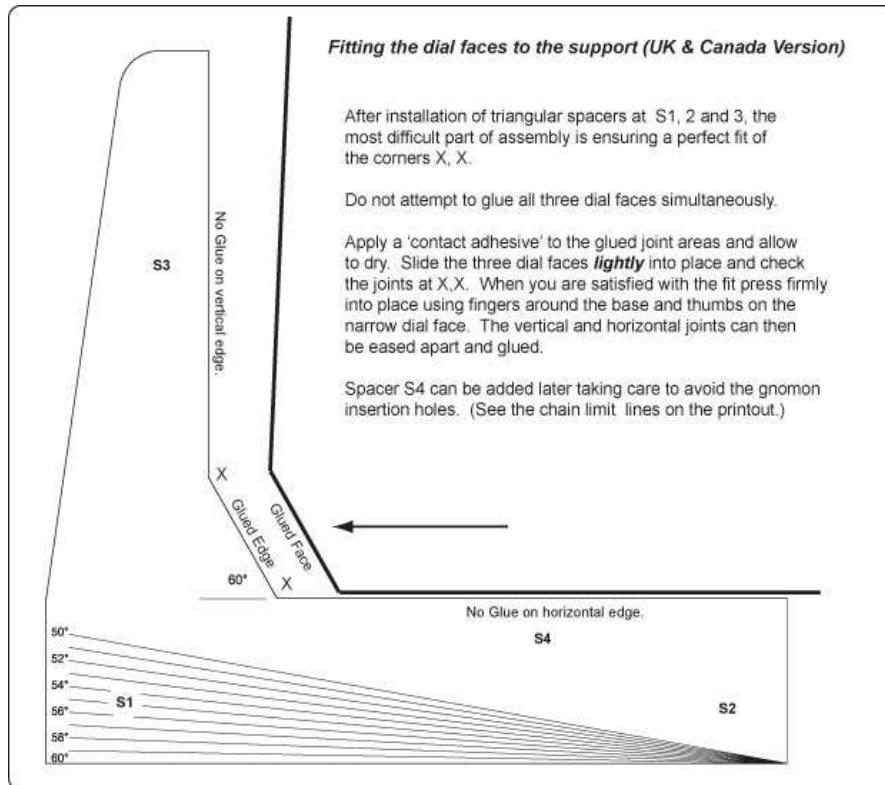
10. Assemble the two side supports held apart by the triangular spaces using white glue on the ends of the spacers. Use improvised wooden paint stick clamps with rubber bands to hold the base assembly together while it dries.



11. Score and Fold the Equatorial section on the tab. Use the glue stick and apply glue to the BACK (without hour lines) of ONLY the tab. The WINTER Equatorial section faces the HORIZONTAL dial of the Multi-Dial section A. The Equatorial section should fit midway on the Polar Dial band, with the numbers 10, 11, 12, 13, 14 of the Equatorial section aligned to the 10, 11, 12, 1, 2 of the Horizontal Dial.



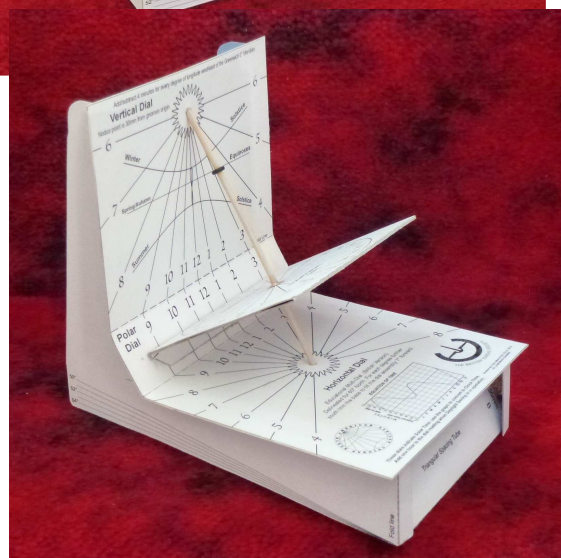
12. Use white glue to hold the Multi-Dial section A (now with the Equatorial section B firmly glued on) onto the base (steps 9 and 10), like assembling the back and seat of a chair. The back of the “chair” is the vertical dial face. The “seat” is the horizontal dial face. Use several rubber bands to hold it in place. Additional glue may be applied from the back side.



Bottom View of Multi-Dial Construction

13. Put the skewer through the holes from horizontal dial upward.

- If you are using the 30-40° Multi-Dial, and if you have a 2.5mm O-ring, slip it on the skewer and



- continue pushing the skewer through the equatorial and vertical dial faces. Make sure that you gently push the O-ring down as the skewer goes up.
- If you are using the 40-50°, or 50-60° Multi-Dial, push the skewer through the equatorial dial face, THEN slip the O-ring on and continue to push the skewer through the vertical dial face.
 - In either case, straighten the equatorial face to be at right angles to the skewer. Trim the length of the skewer to fit. Then use a dab of white glue to hold the skewer in place on the vertical, equatorial and horizontal dial.

14. Move the O-ring so that it appears on the skewer similar to the photo of your dial.

A Note from Tony Moss

The initial inspiration for my Educational Multi-Dial arose from a diagram in ‘Sundials’ by Frank W. Cousins. My own design progressed through plywood and MDF construction in pursuit of something that could be made in schools but most were beyond the modest equipment found in the classroom.

The most significant problem, pointed out in a Sundial Mailing List exchange with teachers, was that there was no adjustment for latitude with my earlier versions. In pursuit of this I began to consider a latitude-adjustable cardboard dial assembly made from discarded breakfast cereal packets with pre-printed paper faces attached. This promising idea came to a dead end when Kellogg’s U.K. were unable to fit it into their programme.

Trimming the base to pre-printed degree lines solved the latitude adjustment so a dial delineated for 50° at the English south coast could be cut and sloped for any latitude up to 60°. At each stage the gnomon remains parallel to the earth’s axis and the dials reads true.

When Fred Sawyer of NASS pointed out that the 50° delineation was useless in the USA it was time for a complete re-think to include three dials covering 30° to 60° north. At the same time I altered the approach so that e.g. the UK/Canada version was delineated for 60° rather than 50°. This improvement meant that the vertical dial face sloped backwards rather than forwards on adjustment and looked more natural.

To reproduce a Multi-Dial for your latitude you will need the card from several large cereal packets, four print-outs covering the dial faces and the supports, a small selection of tools and suitable glues. In England I used a water-based latex adhesive called Copydex which is not available in the US. A web search suggested the following as an equivalent – Elmer’s White Glue

When piercing the holes to take the polestyle gnomon (a bamboo kebab skewer) do so perpendicular to the card face. For the initial hole use e.g. a mounted sewing needle for accuracy. A tapered steel pin or engineers' scriber will enlarge the hole maintaining its true location. The gnomon is inserted after assembly of the dial to distort the holes for its true alignment. For a nodus to track along the seasonal declination lines I used a 2.5mm engineering 'O' ring.

Construction is simple but calls for careful work with a very sharp knife and steel rule. This is work for adult fingers using a safety rule (see photos above). Practice on scrap material before attempting the final version. The assembly diagram and photographs should cover most other aspects.

Download and print the three graphics sheets (laser preferred to waterproof.)
Drape the printed adhesive sheet as in my picture to avoid wrinkles.
Cut out using a Stanley knife or similar and a steel rule on a suitable base. e.g. hardboard.
Cut the sloped lines for latitude **before** folding and glue using e.g. PVA wood adhesive.
A length of bamboo kebab skewer is needed for the polestyle gnomon.
Use the pointed end to pierce the dial origins **before** folding.
Score the chain lines with a blunt knife before folding.

Geographical note: although designed initially to generate educational dials for the UK, USA and Canada, these multi-dials will work equally well in Europe, Russia, China, Korea and Japan at $\pm 0.5^\circ$ of any local latitude between 30° and 60° north.

Tony Moss
March 2014