Designing a Pantometer: a cross-curricular exercise between geography and design & technology

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How a cross-curricular project which started from a real need will now enable whole classes of geography students to measure and record fieldwork data for themselves

This project arose as a result of looking for beneficial ways of exploiting common ground to the two subjects. Year 8, Year 10 and A-level geography students carry out fieldwork on cross-sections of river valleys to highlight terraces, and slope measurements which show the effects of mass movement. The cost of pantometers presently used inhibits the purchase of sufficient numbers to provide a class set.

Current practice

Students carrying out fieldwork on slope measurement currently use a very simply designed pantometer. It is, in effect, a four-bar chain with a 90-degree protractor fixed to one vertical, as shown in Figure 1. A 90-degree protractor limits the versatility of the apparatus: the top bar is restricted to move solely in that quadrant and not permitted to range above the horizontal (this restriction necessitates reversing the frame when the slope changes in sense, which could require users to have their backs to potential hazards). Figure 2 shows its principle of operation.

Proposed design

An alternative design is shown in Figure 3. It uses a protractor made from a rectangular sheet of 3mm thick acrylic, shown in detail in Figure 4. Located in the centre of the top spar, it is easier to read by either of the two students holding the pantometer (illustrated in photograph 1). The cost of this design is in the order of £5, and at this price a class could be equipped with an adequate number to enable all the pupils to participate in the measuring and recording of data.

The design exploits the principle of parallel motion linkages and is held together by seven M5 x 40 cheese head screws, wing nuts and washers. The wood used was 32 x 10 mm section, but any suitable section would be satisfactory as long as combined thicknesses suit the length of the fixing screws. The four top screws, defining the rectangle E x B, form the pivots of the parallel motion, transmitting the slope angle to the protractor.

Vertical alignment could be achieved by fixing a spirit level, but these are prone to breakage. The nylon plumb line affords a cheaper, effective alternative and can be fixed to either leg. To speed set-up, a steel guide prevents the nylon cord from wrapping itself around the leg. Made from holed strip steel, its ends are bent at right angles to form a linear C-shape and screw-fixed in a suitable position. If concern is felt about the effectiveness of the plumb line in high winds, an alternative way of fixing a spirit level using a plastic clip (readily removable during transportation) is feasible. Care would be needed to ensure that it remained properly aligned.

Marking the lines on the acrylic with a steel scriber, to form the protractor, requires patience. An adjustable steel protractor gauge was used and although the outcome was satisfactory, the final appearance was marred by the difficulty encountered in trying to scratch the numbers on the plastic. A simpler but less durable solution is to construct one

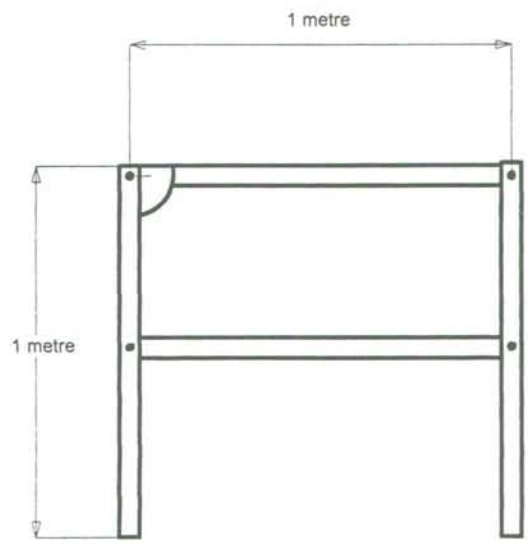


Figure 1

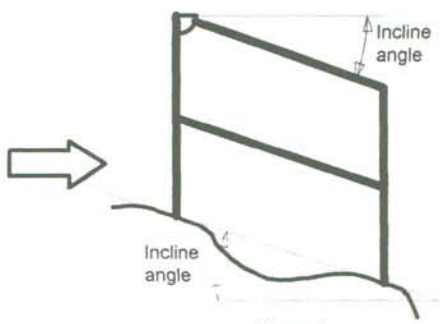


Figure 2

Figures 1 and 2

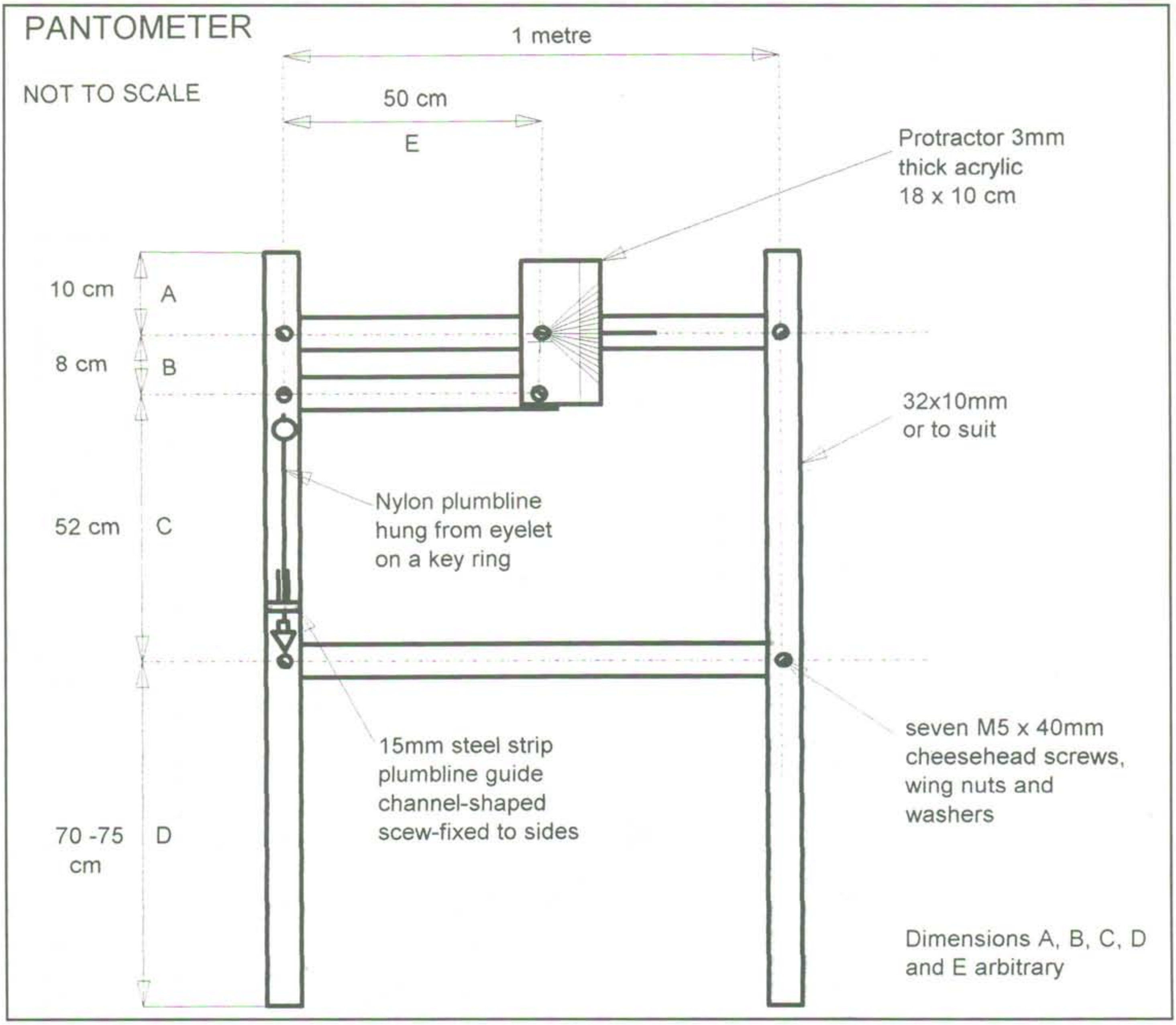


Figure 3

using a CAD package. The resulting plotting can then be glued to the acrylic base. The surface could be water-proofed using a varnish or clear polyurethane spray. Badly scuffed or marked protractors can be replaced with a fresh plotting if necessary.

Other considerations

As the pantometer deals with inclines it might be suitable as a cross-curricular project with mathematics, particularly when the subject of angles of elevation is encountered in trigonometry. It is not difficult to construct a simple model using brass paper-fasteners and good-quality card, to a scale allowing table- or desktop experiments. One such example is shown in photograph 2.

This project provides Key Stage 3 pupils with an opportunity to gain experience in accurate measuring, marking out and cutting as well as demonstrating the principle of parallel motion linkages. If modified slightly, to provide a sighting line, the card model could be used in a classroom to determine the height of the ceiling, for example, if used in conjunction with a ruler and trigonometrical functions. Pupils at KS3/4 should find the manufacture of wooden or card models within their capability, although they may need help in marking out the acrylic protractor.

Figure 4

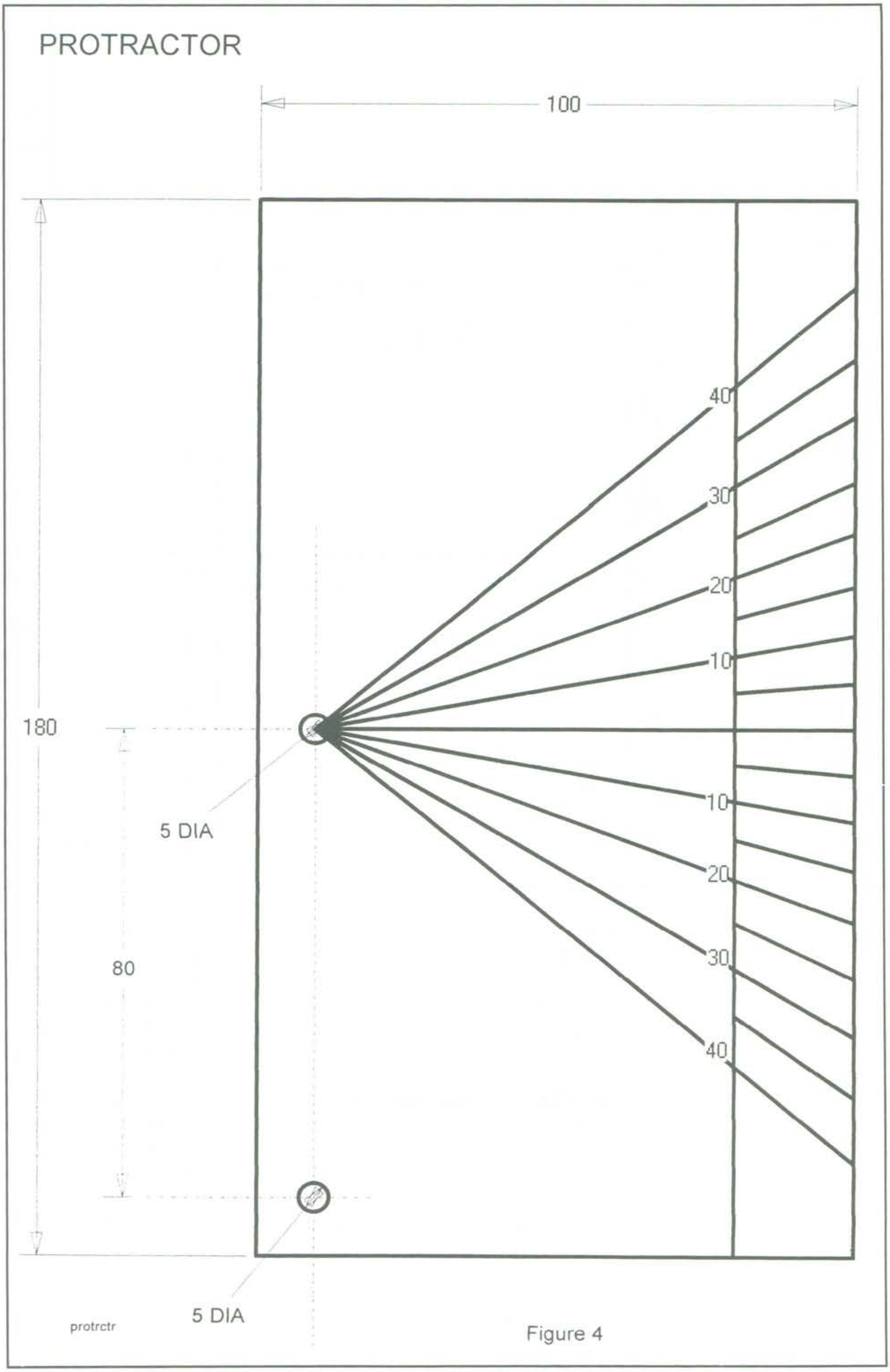
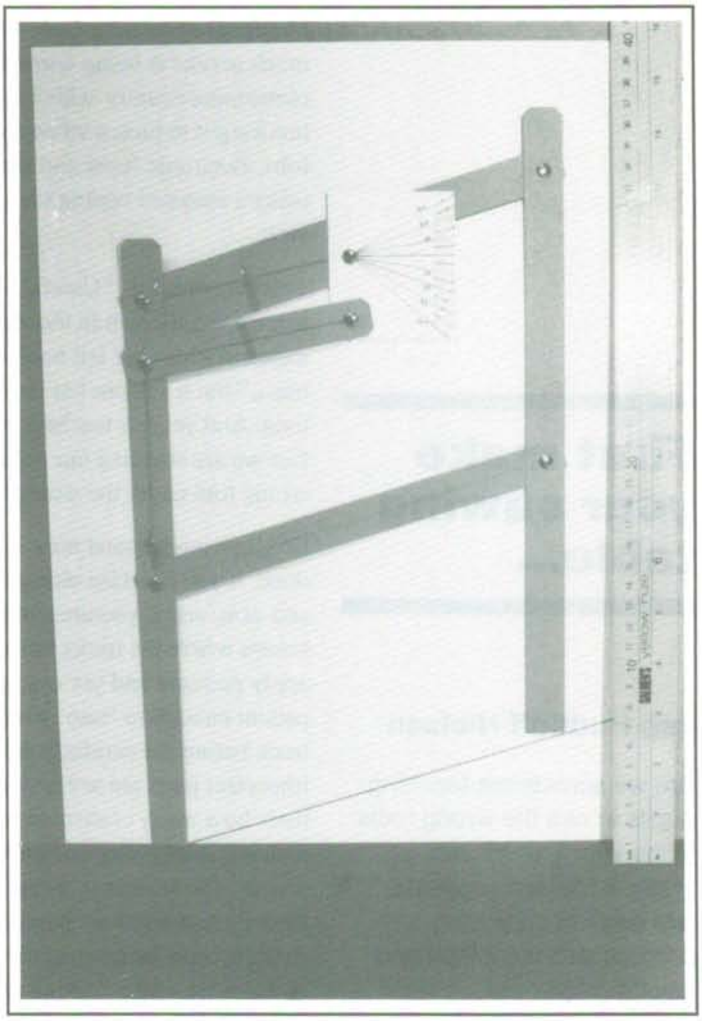


Figure 4



Photographs 1 and 2

Safety

As with all fieldwork, care needs to be taken when working on slopes. Weather and lighting conditions, proximity to cliff edges and sheer faces (above, below and to the side) and proximity to river banks all demand vigilance. The apparatus itself can, of course, prove a hazard if it is left where it can be fallen over.

Conclusion

Finally, a further development could be made using an electronic solution. Angular displacement could be registered by a potentiometer and the signal processed by some suitable circuit with the resulting output calibrated and fed into a LCD. Such an investigation would obviously fit in well with other projects in D&T.

Note: *All the diagrams for this article were plotted on a Plotracer II using DesignView software, part of the Manufacturing by Design package*