IMPROVEMENTS ON COMMERCIAL EQUIPMENT

The preceding section examined the extent to which Caribbean educators had improvised equipment when commercially produced models were in short supply. Among the roles of the science teacher, Silber (1979) has included that of experimenter/tinkerer, and some teachers improve on their commercial stocks for educational reasons. It may be an improvement to allow the commercial pinhole camera kit to gather dust on the shelves while the children are given toilet paper cardboard cores, carbon paper, greaseproof paper, rubber bands and pins. Improvements may convey the concept better, or show children that science is all around them, or facilitate investigations at home, drawing family members into the child's experience and giving them a better understanding of what the school is trying to do, or be more convenient to use, more flexible or more easily repaired. In the Caribbean, improvements appear to have been few.

Of course, what is an improvement to one teacher will certainly be described as an inadequate substitute by other teachers. A school in Guyana was found to have burette stands made by the school carpenter, the burette being held by spring clothes pegs nailed to a frame. The risk of damage to burettes was less than from the conventional design, which screws, and the whole stand, though quite robust, could be repaired easily. The incumbent teacher, however, was unimpressed because it did not look like 'the real thing'.

Science educators in the Commonwealth may find some new ideas among the following short description. The first eleven items were contributed by one teacher of physics and integrated science in Jamaica (27); sources of the other items are as indicated.

Circuit boards were quickly made as a large class set some ten years ago and have given good service ever since. They are readily repaired. The base is a simple square of 2.5 cm plywood; the pegs are flat-headed aluminium nails driven through the plywood using a template to ensure exact spacing; the battery holder is a set of four fuse-holders fixed at appropriate distances apart to provide springy connections for the cells; the connectors between components are strap steel taken from wooden crates.

Pinhole cameras made from chalk boxes may be adjusted in length by pulling the two sections of the box apart.

Lamps for optics work consist of well-ventilated wooden boxes lit by mains bulbs, readily replaceable. The 'object' is a triangular aperture which may be covered with a scrap of wire gauze to facilitate sharp focusing. If the sides of the triangle are made to be exactly 1 cm, quantitative work is simplified. One mains outlet can safely supply three such lamps which are therefore not dependent on a good supply of low voltage power packs.

Resistance boxes can be constructed from a few standard resistors and a few terminals to provide resistances of up to 50 or more ohms in steps of 1 or 2 ohms.

Electrical meters. In an ammeter, voltmeter or galvanometer, the main cost is in the 'movement'. Teachers need a good range of meters, and often find it difficult to provide enough of each range for class sets. It so happens that the commercial meters bought in variety by teachers are generally based on only a single basic movement, perhaps capable of carrying currents up to 15 mA. Difference in performance is provided by different resistances connected in series or parallel by the manufacturer. Since any O Level candidate is expected to be able to work out the resistance required for a particular job, it is not at all difficult for a teacher, given a class set of galvanometers, to design and put together meters to serve all his needs for galvanometers, ammeters and voltmeters of whatever ranges. (He does, however, need a good assortment of high resistances and of resistance wire which, though not expensive, did not appear from the Caribbean survey to be well stocked.)

Rheostats. Components of all kinds of electrical equipment in common use, rheostats (sometimes called potentiometers) may be scavenged from unserviceable domestic appliances or surplus stocks. Mounted for ready connection in the school laboratory, they provide adjustable resistances.

Apparatus to investigate the magnetic effect of an electric current. An important component of a physics course, this investigation demands a piece of demonstration equipment (or many different pieces of equipment) not available to many teachers. It demands an exploration of the effect on a magnet of varying the current, the length of the conductor and the radius of the current-carrying conductor, combined with a facility to control variables. A wooden board with a slot to carry the magnetic needle (which may come from a tangent galvanometer) contains large-headed nails arranged in concentric circles so that insulated wire can be wrapped round any of the circles as many times as required. Since the board must be mounted vertically, it is convenient to provide it with a foot.

Apparatus to investigate the electrical effect of a magnet. Given some good bar magnets, the apparatus is readily constructed by winding lacquered copper wire (readily obtained from discarded appliances) round hollow formers, for example, short lengths of plastic piping. The electrical effect is readily demonstrated, and the laws of electromagnetic induction investigated.

Tangent galvanometers. The coil can be made by winding insultated copper wire round a short length of a cylindrical tube, such as a container. The pivoted magnetic needle and scale are nevertheless commercial models.

Lever kit. The Nuffield physics lever kit lends itself readily to local production. The grooved levers and fulcrums are quickly made from wood by a carpenter with ordinary tools. The square 'pennies' are cut in a metal workshop from a strip of brass. After checking their masses on a laboratory balance, the heaviest ones have a small hole drilled in the centre. Final adjustments with a touch of solder make the masses uniform.

Current balances. These have been made in Jamaica, although details of the design are not available (27). The current balance, incidentally, provides an example of where local production can go wrong. The UWI School of Education at St Augustine has some supplied by UNESCO designed apparently by someone who did not know how a current balance is used. The mini-magnets are polarised across the wrong dimension, which means that a current of any magnitude will exert a strong force on the magnet, so that the current balance cannot be used quantitatively.

X ray photographs. Some teachers use X rays from a friendly dentist in preference to a wall chart of tooth decay (33).

Wall charts. The educational implications of having wall charts made by sixth-form scientists or by children working with the art teacher are obvious (34, 35).

Force measurers. WISCIP provides a design for push-pull measurers superior to spring balances, which can only pull. Children make their own force-measurers from bamboo or plastic pipe and take them home (34).

Prisms. A plane mirrow in a bowl of water in the sunshine provides an excellent spectrum, and can lead to a discussion of more physical principles than are involved in the use of the simple glass prism, which is usually chipped or broken anyway. (6, 36).

Strobescope (flasher). Five of the 29 schools in the O Level physics survey had xenon stroboscopes, which are very useful if one can afford them. However, the Guyana Report mentions a strobe flasher made by a teacher who connected a bulb to a signal generator. No details are provided, but it is unlikely that this on-the-spot flasher would serve exactly the same purposes as a xenon strobe. One is tempted to make an empirical investigation of suitable lamps and output terminals, and to explore the educational opportunities.

There may, of course, be many other examples from energetic and imaginative teachers in the Caribbean, but they did not come to light in the survey, which showed beyond doubt that the majority of teachers do not improve on commercial designs for anything. The term 'energetic and imaginative' is used to describe the foregoing list, although it is possible that some or all have been described in the extensive science education literature. Teachers do not generally have, as a resource, guidebooks on in-school construction although the Maryland Guides (Lockard, 1972) and others were written for just this purpose. Journals from science teachers' associations, School Science Review and Science Teacher for example, and the ASE Lab Books, tend to be expensive and few science teachers belong to an association other than their own local one, most of which in the Caribbean do not produce regular publications. It seems fair, then, to describe teachers who pounce on the designs in the literature, and/or who design their own, as energetic and imaginative improvers. They have had little help from their universities, Ministries of Education and associations. The author of this paper, a member of one of the universities and of two of the associations, has anyway found most of the teachers' improvements in the above list stimulating and useful. One teacher (Yhip, 1979) favouring a 'more blue-collared approach to implementing science courses', has outlined some 'job-cards' which, used in workshops of educators, could increase sensitivity to such an approach and lead to the planning of strategies for small and large scale production.