It is surprising how many school architects are unaware of the need for flexibility in a laboratory. The great majority of Caribbean school laboratories are furnished with massive fixed benches which make small group work impossible and limit the range of strategies available to the teacher. The older chemistry laboratories are particularly awkward, tending to confront the child with a rack of bottles which cannot be seen through so that their view of the environment is limited to a couple of metres on either side. When the bottle racks are unscrewed and discarded, or turned into book-shelves elsewhere in the school, teachers and children are enchanted with the change in social climate of the room (37). When the benches are not fixed, they tend anyway to be too heavy for children to rearrange quickly; and teachers tend to arrange for one group per bench, which leads to 'groups' being as large as ten children.

The older benches tend to be made of excellent hardwood, and can readily be cut down to two-person tables, sanded and covered with plyurethane varnish. A modular strategy proves effective. This means that if the length of a table is twice its width, and if any fixed units and trolleys have both sides equal to the width of a table, the furniture can be arranged in a multiplicity of ways. Since a single table of dimensions about 1½ metre by ¾ metre can comfortably accommodate two children, a useful modular dimension would be about ¾ metre, although this is subject to modification within the constraints of floor area of the room available and the number of children to be accommodated. Benches also tend to be too high and chemistry laboratories in particular appear to have been designed for a standing population. It is no wonder that children have to climb on to stools to use burettes. Tall benches demand tall stools quite unrelated to the length of a child's legs and tending to be unstable. A suitable bench height for medium-sized children is about the height of an ordinary office desk, and office tables assembled by local furniture manufacturers may well prove excellent as laboratory tables. Laboratories furnished according to these principles may be used in a variety of ways. For school functions, the tables are available for use elsewhere in the school. It is of interest that such a laboratory is much cheaper to build than the conventional type.

Laminated table tops have not proved satisfactory. They are expensive and non-resistant to many of the activities that go on in a laboratory. A polyurethaned hardwood surface is more resistant to most chemicals and heat, and is easily restored. Fibreboard does not stand up well to leaky taps. It follows that wooden furniture should be used when feasible.

Many schools do not have enough laboratories, and the younger children tend to be denied access to those that exist. Some teachers have provided quite satisfactory classroom arrangements by treating the desks as the modules; desks with sloping tops may need to have their lids propped up with blocks of wood (38).

A flexible laboratory calls on the ingenuity of the designer if services (water, gas and electricity) are to be available to children. Some solutions are outlined below.

Water

For most purposes, a fixed unit will be required. A cover to the sink converts this space to a working unit for other purposes when necessary. It may be noted in passing that most laboratory sinks are far larger than they need to be, making unnecessary demands on space. When a classroom must be the laboratory, it is possible to solve some of the plumbing problems by providing a few buckets of water. One teacher has found a solution which may be original. It is worth quoting her report verbatim.

> 'My boys and I have found a fairly reasonable solution to the sink problem in the classroom...Some of them came up with the brilliant idea of using large Vaseline Intensive Care bottles with the squeeze down type of jet. With these bottles, they can control the amount of water being poured out quite easily and also, if the bottles fall, there isn't much spillage! So that's our tap. Our sink consists of a 250 mL styrotex cup. Twenty five of these cost less than $2 and the cups can also be used for storing hot water and as a beaker when large volumes are being worked with. We try to use test tubes as much as possible to cut down on volumes where possible' (39).

Gas

Two possible solutions have been identified. The first provides the gas lines and outlets along the walls or on fixed service islands placed strategically round the room. Unless well thought out, they could lead to crowding of the children in too small a space, providing a hazard; one teacher in Jamaica, faced with a laboratory with gas taps on only two walls, refused to do any gas work at all. Many educators would agree with the soundness of his position although perhaps more would be willing to take chances on the safety of the children. The second solution is usually a consequence of problems with providing the school with a central gas supply, which in the Caribbean commonly comes from 100 lb cylinders distributing their propane or butane gas through built-in pipes. Pipes corrode and sometimes large gas cylinders are in short supply, and, often, a school is opened long before any gas is installed. Teachers faced with this kind of problem have picked up portable 25 lb cylinders and joined them in some way to the children's bunsen burners, either through existing uncorroded gas lines or through rubber tubing (40). However, there are hazards which need careful exploration: there may be only one control cock; connections can fall off; suck-back from one burner may affect other users; and the gas reservoir is in the laboratory, where it could cause an explosion.

Electricity

Unless one uses cells and batteries, pupils at their tables need to be able to reach a mains electrical outlet. Several effective solutions have been found, and choice from these will depend on the conditions in the laboratory.

1. Power outlets are available at the wall only. As with the distribution of gas mentioned above, this could lead to crowding at the walls.

2. Power outlets available from overhead. Ordinary overhead light sockets fitted with appropriate adaptors can provide drop cords to apparatus. There is little danger of children falling over wires, but the teacher needs to employ a simple calculation to ensure that the socket is not over-loaded, which is unlikely, given the load from school electrical equipment and the tolerance of the fittings in buildings.

3. Distribution from wall outlets. One school has fitted its small tables with double sockets of the standard mains type. With the aid of connecting leads with male pins at both ends, the tables can be connected to one another and to the wall outlets in any sequence. This strategy, while very neat, does provide hazards which could be dangerous in the hands of an inexperienced teacher: (a) children can trip over the wires; (b) a lead with a male connection at the output end can cause a shock to a mischievous child being taught by an inexperienced teacher; (c) the circuit may become overloaded.

4. Power outlets available in the floor, a high risk situation in a laboratory which also has plumbing. Flooding, and cleaning staff with wet mops, are other hazards which provide good reasons for avoiding this type of installation, and it has not been observed in the Caribbean.

Once there are no fixtures except on the walls, the science room, having maximum flexibility, becomes a much more useful place in the school than a mere laboratory. However, the provision of a few fixed service islands (of modular dimensions) does not much reduce flexibility and provides plumbing as well as gas and electricity throughout the room. Up to four tables may be served by each island, so that a class of 32 children working in pairs would be adequately served by four islands; perhaps the teacher would need a fifth island to which could be joined modular trolleys and/or tables to make a demonstration bench. If the sink is sunken and fitted with a removable cover, each island can provide an extra working surface. Some of the laboratories of the multilateral schools of Guyana have service islands carrying electricity and gas at strategic locations within the room, while others have wall islands which carry plumbing only.

Laboratories in the Caribbean have sacrificed black-out facilities for ventilation. More recently-built ones tend to have adjustable metal or (more satisfactory) wooden louvres, which could darken a room very quickly were it not that somewhere in the room there is usually a glass or wire-covered window. Older laboratories are likely to have glass windows. When these are painted dark green or boarded over with plywood, partial to total blackout becomes available. Such a modification makes the room suitable for optics and other experiments, and for the use of all kinds of visual aids. This strategy is more satisfactory in the tropics than much more expensive options such as curtains and blinds (41). The usual pin-board, or even a white wall, doubles as a satisfactory projection screen. A sheet of galvanised iron, painted some appropriate colour, acts as a useful magnet board and can serve other purposes as well, depending on its colour. The plywood on the windows can even serve as a set of chalkboards.

Where there is a separate storeroom, storage facilities within the laboratory are little used as teachers find that children tend to interfere both with the cupboards and the apparatus in them. Laboratory cupboards therefore simply take up space and may give the laboratory a derelict appearance. The storage capacity of a small storeroom can be increased by storing some apparatus on trolleys standing against the fixed shelves but easily moved. Trolleys are almost essential for moving apparatus into and around the laboratory, and have a range of other uses as well, including macro-kinematics investigations. They are readily made locally from angle-iron and bagasse (fibre) board.

Storage and transport trays are also of great value. Wooden trays which have for decades served a teacher in Jamaica without a laboratory assistant, and small plastic boxes, once containing surgical sutures and obtained from hospitals, are ideal (27). In Guyana, the school carpenter designed and built storage boxes with sliding lids. The boxes are long enough to hold thermometer cases, and wide and deep enough to hold glass blocks for optics experiments. Fitted with partitions they hold lenses and mirrors (38).

The Guyana Report discusses the importance of planning for storage. In primary schools one of the biggest obstacles to the teaching of science is the fact that the classrooms are generally not equipped with secure cupboards, and indeed the rooms themselves are easily broken into by vandals. While the primary curriculum under development in Trinidad and Tobago demands the usual inexpensive and locally-available materials, it demands quite a variety of these and most teachers do not have the time or money to buy what they need for each lesson. The designers of SAPATT have put together a kit of these simple materials all contained in a strong wooden box which can be padlocked and kept in the Principal's office if necessary (9). The same precaution has been observed in Jamaica and the Bahamas, usually (and unfortunately) with the consequence that the materials spend much more time in the Principal's office than in the classroom. It is unrealistic to expect the majority of teachers to plan ahead in order to arrange for all materials to be in the classroom in advance of the lesson. Indeed, it would be impossible for the primary teacher prepared to respond to stimulus from the children. Similarly, a science resource centre, while economically attractive, will not do much to meet the needs of either the disorganised teacher or the flexible one. Teachers need to be able to put their hands on resources at once.