Technology in School: Some Alternative Approaches

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This is the first of three short articles whose purpose is to examine a variety of ideas which, taken collectively, might be said to represent an 'appropriate technology' approach to CDT work. The subjects considered range widely from pneumatic toys to relatively exotic metal forming techniques, but common to all of them is the notion that getting technology into school can actually cost very little or nothing at all.

It will become clear, I imagine, that many of these ideas might be applied in different ways right across the school age range; what follows therefore is not intended to be prescriptive – that is, a miscellaneous collection of potential 'jobs' or experiments. Rather, it aims to draw attention to some interesting possibilities that appear to merit further thought.

Figure 1: A simple and cheap pneumatic system using a detergent bottle, PVC tubing and a baloon.

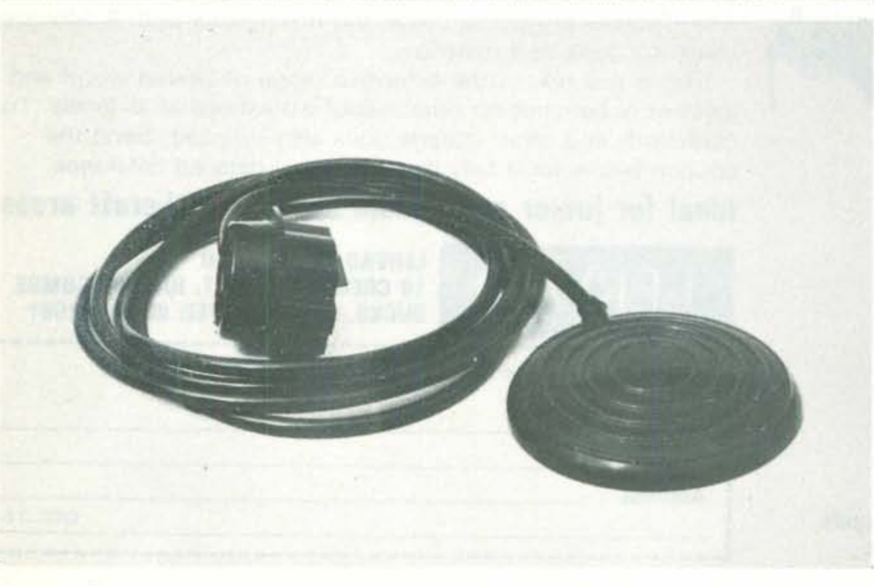


Figure 2: Pneumatically operated switch – of particular value in an electrically unsafe working environement.

Hydraulics, Pneumatics and Toys

It hardly needs restating that in recent years a lot of attention has been devoted to working out formal courses in technology and devising apparatus suitable for school use. The range of equipment available for Schools Council control technology work (pneumatics, electronics, mechanics) is probably the most familiar in CDT departments, but of course other kits are obtainable for experiments in hydraulics, fluidics and so on. Undoubtedly, much of the available apparatus is good value, and what follows in no way suggests that cheaper substitute systems can be assembled at a fraction of the cost to do the same job. What is suggested, however, is that where certain commercial equipment is unavailable for whatever reason, alternative strategies exist particularly when it comes to the construction of models or prototypes.

Two areas which seem to lend themselves well to the 'appropriate' treatment are pneumatics and hydraulics. In the case of pneumatics extremely simple systems can be manufactured from little more than household throw-outs, though it has to be admitted that these have a comparatively limited application in the wider context of pneumatic control. In the case of hydraulics, however, a combination of cheap disposable syringes, PVC tubing and standard laboratory fittings can be used in endless ways to make up simple or complex systems capable of demonstrating most basic principles and representing commercially important applications.

The most simple form of pneumatic system can be assembled using PVC tubing as shown in Fig. I; when the bottle is squeezed, the balloon expands. This arrangement is hardly original and requires no further explanation beyond pointing out that systems working on this principle are often employed in light machinery as substitutes for mechanical linkages. Among other examples may be cited the pneumatically operated switch seen in Fig. 2 where a pulse of air from the small bellows actuates a diaphram at the switch.

Clearly, a useful principle can be effectively demonstrated, but it can also be exploited in a number of ways. Figs. 3 and 4 illustrate two delightful toys both of which use the balloon/bottle arrangement and both of which were conceived as possible outcomes of design and make work in school. The tank model is essentially a box containing the balloon upon which the loose fitting figure stands. Normally concealed under the hatch, it rises about two inches when the balloon is

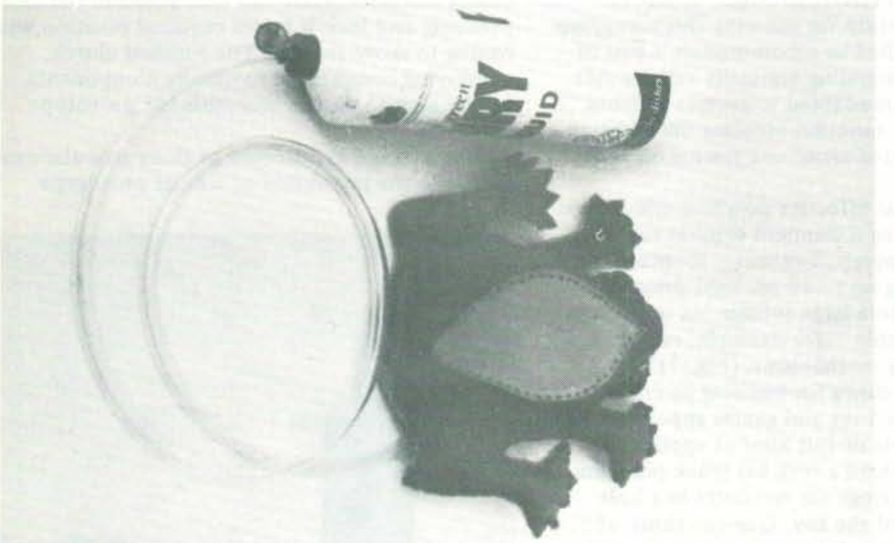
Top left: Figure 3. Jumping frog toy incorporating the pneumatics shown in Figure 1.
Bottom left: Figure 4. Tank toy incorporating the pneumatics shown in Fig. 1 to raise the figure up and down.
Top right: Figure 5. A simple hydraulic system comprising two syringes connected with PVC tubing and water filled.
Bottom left: Figure 6. A hydraulic system comprising in effect, a master cylinder (rear) and two slave cylinders.

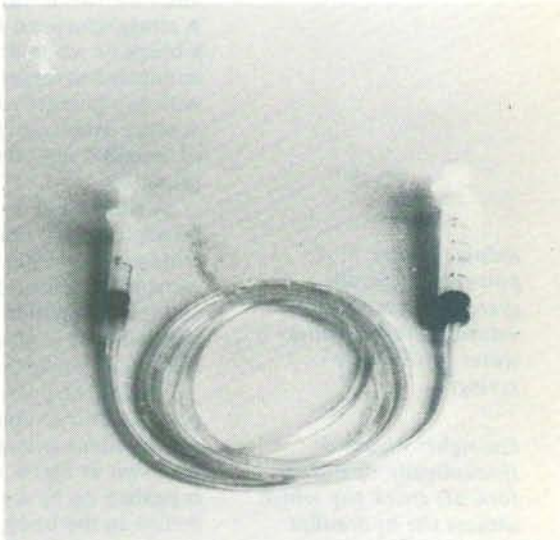
inflated. This type of model is potentially simple to construct, the pneumatics are not in the least critical, and the end result is a toy with the facility for movement-at-a-distance which imbues it with an interest out of all proportion to the simplicity and cost of the system itself.

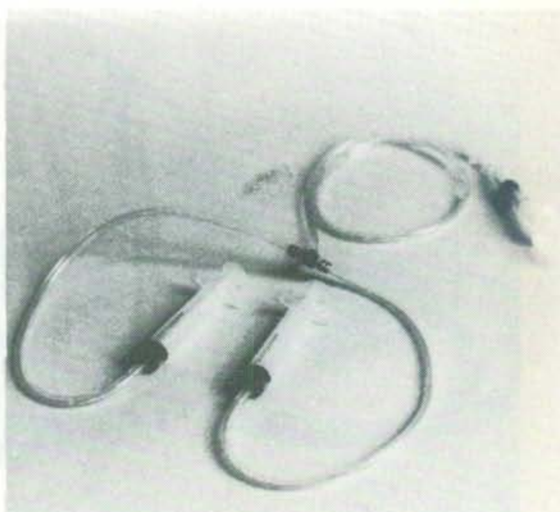
The pneumatic frog (Fig. 3) is even more straightforward in construction consisting only of a flat wooden armature upholstered in felt and containing a balloon in the lining underneath. Interestingly, the action of this model is rather more a lurch than a hop when the bottle is squeezed, and this illustrates an important feature of the system: its inertia. This has to be taken account of when designing for any type of 'snap' action since this necessitates using the pneumatics as a trigger to release – say – a critically balanced length of tensioned elastic.

Other applications come readily to mind, especially in relation to toy and model construction. Design briefs involving the use of simple pneumatics can be framed to suit very different levels of thinking, and of course this would determine the appropriateness of introducing any sort of quantitative consideration of the system's performance.

The pneumatic arrangement described would seem to have much to commend it as a means of adding an interesting dimension to certain kinds of projects, but this type of closed system is hardly representative of pneumatic control techniques beyond the sort of examples already mentioned. This is not so much an objection, however, when thinking about and devising hydraulic systems based on the use of disposable syringes – although it has to be admitted that a normal syringe, in hydraulic terms, is only single-acting.







There can, perhaps, be few more meaningful introductions to the way a typical hydraulic system functions than by taking up a pair of water filled interconnected syringes (Fig. 5), one in each hand, and getting an impression of the effect of alternately depressing the two plungers. If the piston areas are dissimilar (say, in the ratio of 2:1) the idea of obtaining an advantage by this means becomes intuitively obvious. Even the problem of air entrainment in such a system can be clearly demonstrated by introducing a pocket of air and comparing the original positive action with the resulting 'spongy' deterioration.

Another simple configuration is shown (Fig. 6) with a 'master cylinder' and two 'slaves'; more of these can obviously be added to simulate more extensive systems. Semi-quantitative demonstrations are also possible showing, for example, how advantage is a function of relative piston areas and how this in turn relates to length of stroke. A straightforward set-up for showing this comprises a block of wood drilled to accommodate a pair of connected syringes standing vertically side by side, with the plunger tops adapted to receive weights. A more satisfactory variation involves the addition of weight-hung pivoted arms, one resting on each plunger.

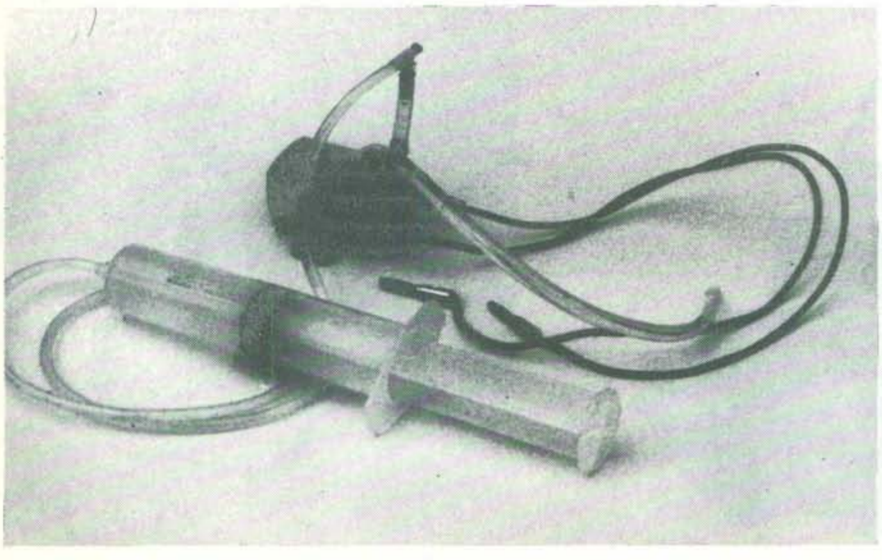
A simple but most effective powered system can be made up by adding a standard electric car windscreen washer pump. Typically, these are capable of delivering up to 40 psi fluid pressure, and when supplied to a large syringe, an impressive performance is possible – for example, raising heavy weights or operating mechanisms. (Fig. 7).

Again, the possibilities for building hydraulic systems into models, toys and games appear endless. An excellent example of this kind of application is shown in Fig. 8 where a fork lift truck platform is pushed up by a syringe set vertically in a hole drilled in the body of the toy. One can think of similar applications involving simpler mechanical arrangements; for example, a stylized bulldozer, excavator or tipper truck, each with a single pivoted moving component. (Atmospheric pressure is normally sufficient for the return stroke when the controlling syringe is pulled rather than pushed but – exceptionally – a return spring can also be built in at the slave end.)

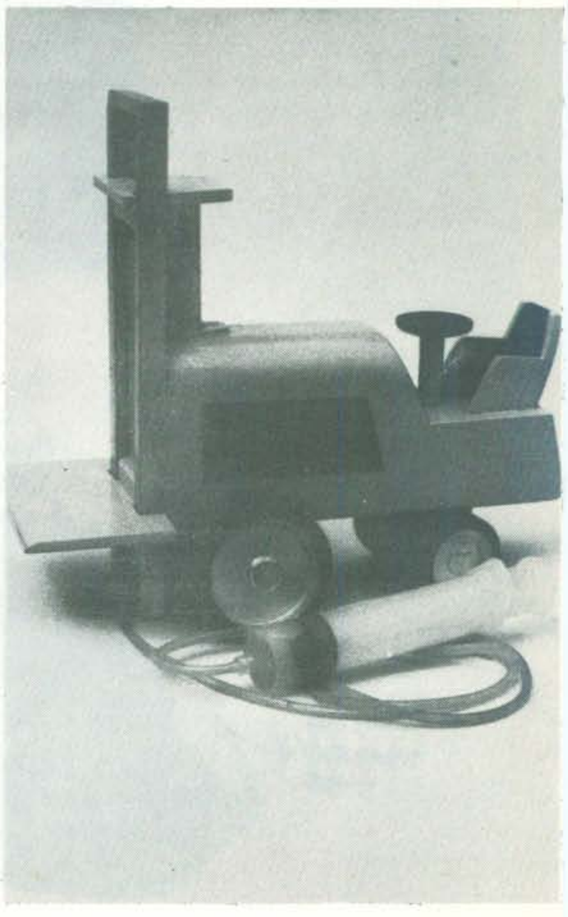
Hydraulic systems put together in this way appea to be potentially useful in other types of work, particularly when it comes to trying out ideas in prototype form. Fig. 9 illustrates the use of just sucl a system in the prototype of a very sophisticated clutch assembly, envisaged as part of a universally adjustable camera mounting for specialised (especially low level) photography. In the completed version of the whole mounting (Fig. 10) the camera boom is normally held rigid by two clutches at the tripod end, but the operator is able to release these via a hydraulic system whose controls are mounted beside the camera. He can thus position the camera precisely and lock it in the required position withou having to move from it. The finished clutch, employing commercial hydraulic components, can be seen to closely resemble the prototype (Fig. 11).

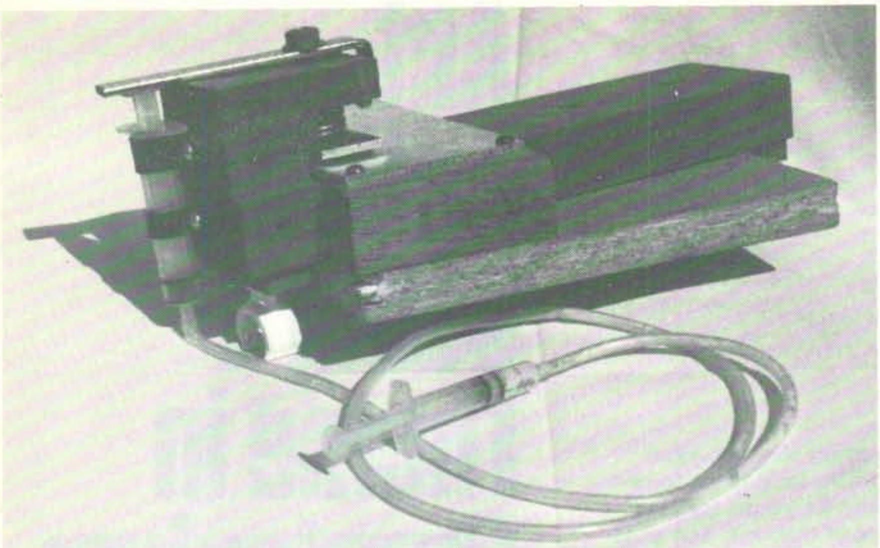
The successful outcome of this particular exampl points to the possibility of similar prototype

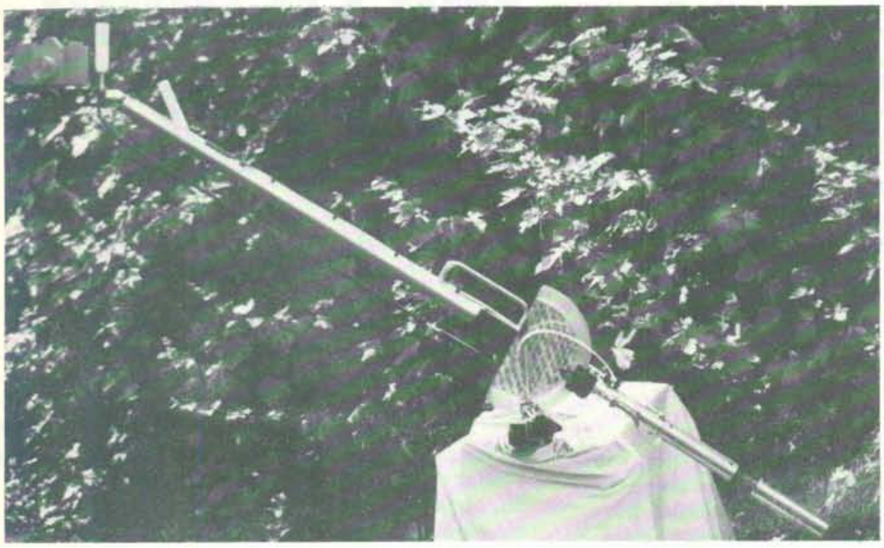
Below: Figure 7: A powered hydraulic system. A car windscreen washer pump supplies water to the large syringe.



Far right: Figure 8: Hydaulically operated fork lift truck toy which utilises the hydraulics shown in Figure 5.







Above:
Figure 11.
Detail of the final clutch assembly showing commercial hydraulic components in position.

Top left:
Figure 9:
The prototype of a hydraulically operated clutch assembly, illustating the value of syringe hydraulics in prototype work.

Above:
Figure 10:
Universally adjustable camera mounting. The main principle of operation was proved by the prototype assembly shown in Figure 9.

applications – for example, in 'A' level project work where any tentative thoughts about incorporating hydraulics in a design solution might otherwise be ruled out on the grounds of cost or availability of suitable components. And it should be noted that hydraulic systems put together in this way are extremely durable and robust. Most syringes will comfortably accept very high fluid pressures, and usually only fail because of distortion of the plunger stem itself when under extreme load. (It may also be worth pointing out that as a means of getting a movement from A to B a pair of syringes plus a length of PVC tubing can be far cheaper even than a cable.)

The existing scheme of things within individual schools will naturally determine whether any of the forgoing is seen to be 'appropriate' or not. I would think, however, that some of the possibilities considered above could be worth developing irrespective of the nature of established mainstream activities. As a means of supplementing work in this area, or introducing it afresh, it clearly holds out the promise of being instructive, interesting and – unashamedly – just good fun.

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Mrs. Judy Fenton O'Greevy. (Frog toy)
Mrs. Jeanne Bower. (Tank toy)
Mr. Simon Williams. (Camera mounting)
Mr. David Carter. (Fork lift truck model)

Component suppliers
PVC tubing.
Downswood Products Limited,
Park Lane,
Knebworth,
Herts., SG3 6PJ.
3mm bore tubing is the most useful size for syringes up to 10ml capacity and for fitting to detergent bottles. A 30 metre roll will cost only approx. £1.50 from the above firm.
Disposable syringes.
Southern Syringe Services Limited,
New Universal House,
303, Chase Side,
Southgate,
London, N14 6JB.
2ml, 5ml, and 10ml capacity syringes are useful sizes for most of the work described. Various makes can be obtained, and most have nozzles suitable for pushing on PVC tubing. The above firm will probably only supply syringes in quantity but this brings the unit cost down to just a few pence.
The firm below will supply small or large numbers.
Griffin & George Limited (London),
285, Ealing Road,
Wembley,
Middlesex, HA0 1JH.

Note: Needles may sometimes be provided with syringes, and great care should be taken to ensure their destruction.