Muscling in: using Shadow Muscles for Modelling

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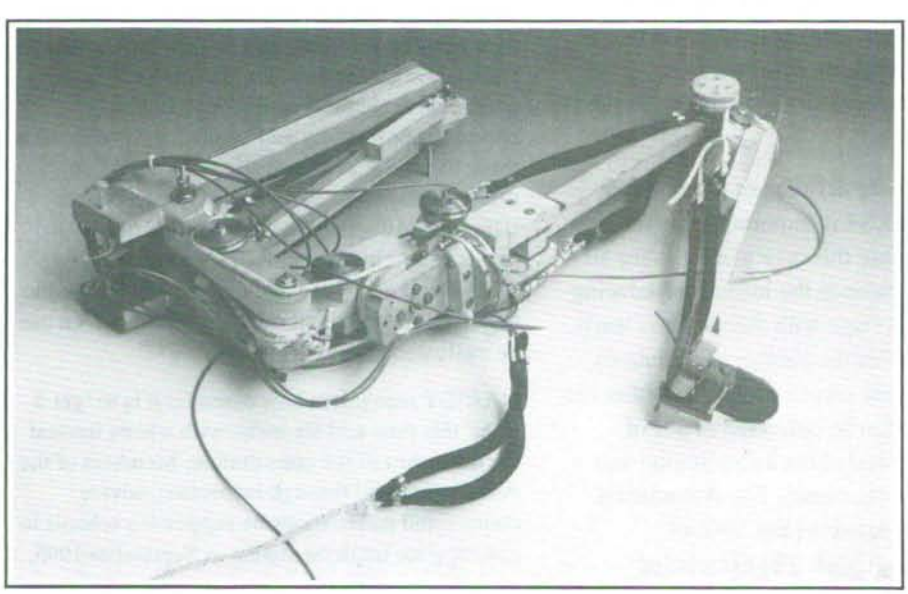
I was recently bemoaning the inadequacies of pneumatic equipment for technology when a friend drew my attention to a new development by Shadow Project, called Shadow Muscles. Intrigued by what I heard, I contacted them and was lent a set to try out.

A Shadow Muscle looks like a long thin rubber bag in a tube of black plastic mesh similar to the nets which oranges are packed in. They come in different sizes, most being about 10cm long and 2cm wide; the longest is about 30cm long and 2cm wide. Metal clips which can be squeezed on to close each end form loops in the plastic mesh for fixing, and an air tube emerges from one end. When you allow pressurised air into the tube, the rubber bag expands and the mesh, also expanded, shortens its length and produces a pull on both ends. The plastic mesh restrains the rubber bag so that it can expand fairly uniformly down its length. They work (and look) like a human biceps muscle bending an arm and this analogy produced the most rewarding model I made with them.

Shadow Muscle is a brilliantly simple concept and much of the cleverness of this system lies in the software, interface and air control. On a sturdy base plate is the computer interface and four air control valves which require an external supply of pressurised air. The air pipes are easy to fit and helpful diagrams show you how to connect them. You can work them directly by inflating one muscle from each valve, or use two valves for each muscle, which allows you to inflate the muscle, hold it inflated and actively empty it, all with precise control.

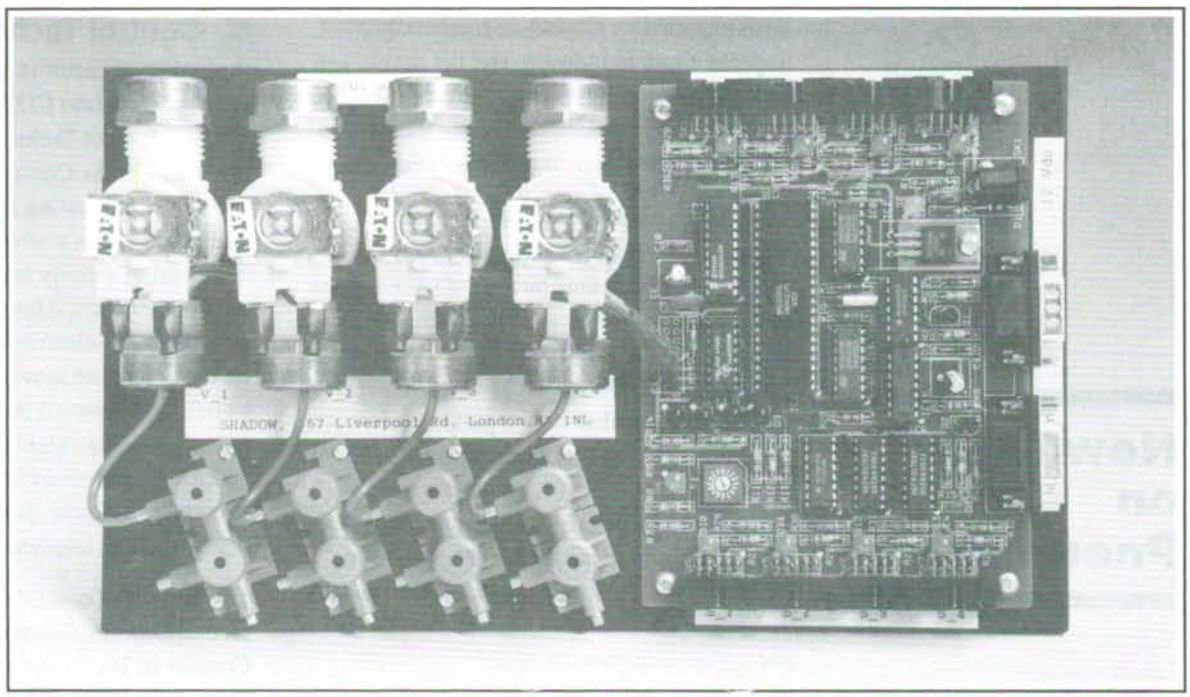


The interface is well built but unboxed. I like to see the electronics showing: this helps to remove the black box mystique, but some people may find it intimidating, and others may be tempted to tamper with it. The interface connects with the serial port on the computer and has an expansion port which enables the connection of additional interfaces and air valves, and sockets for the connection of sensors. The sensors are also sturdy with well made, easily obtainable components such as switches which could easily be adapted to the user's requirements. The software, which I used with an Acorn Archimedes, is very visual, easy to use and very forgiving. I found the direct control facility invaluable for testing the operation of mechanisms I had built, before I began to program them.

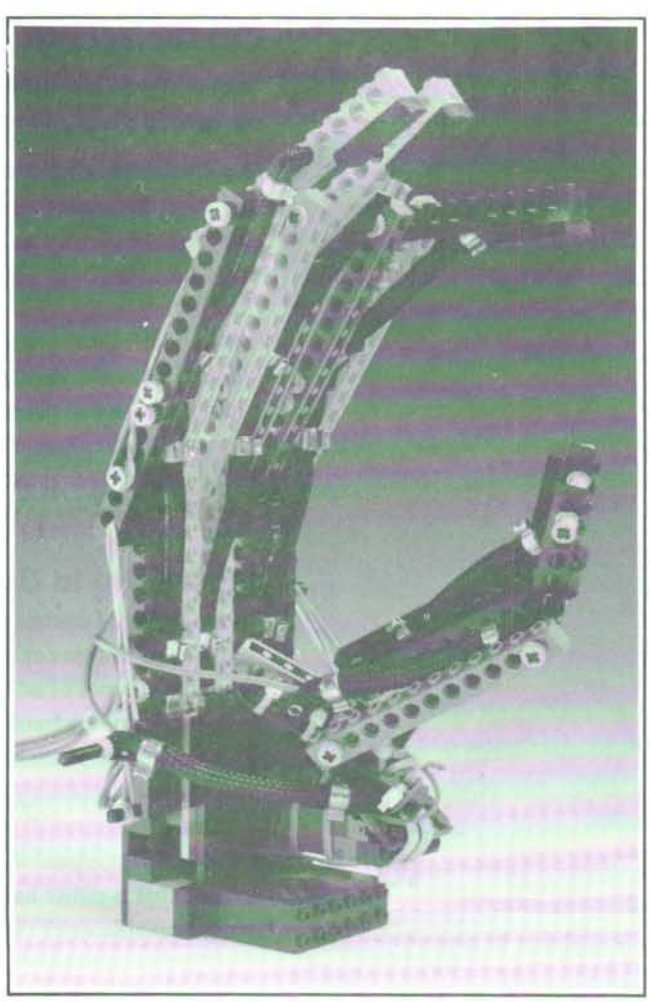
I had several days of entertainment from using the system. Fairly experienced in the use of interfaces and control mechanisms, I was pleasantly surprised by the ease with which I could build and use models with this system. The first model I tried was a Lego version of a life-sized animated head, which was originally built as an illustration for the NCET IT in D&T GEST material. The large original had taken a colleague several days to build from wood and was driven by large, conventional pneumatic valves controlled by a separate interface. My Lego and Shadow Muscle version was roughly half life size and although not as smoothly operating as the original, performed almost all the same functions: the head turned, the tongue went in and out and the eyes and ears moved. My model took about two hours to build, and I spent less than half an hour producing a workable program.

Using the muscles rather than the usual pneumatic brute force pistons made me think much more carefully about the angles and positions used in the construction. The muscles and the elastic bands used as antagonists to the muscles exert a tremendous static force on the model, and several times joints collapsed under these forces. At one point I managed to get the muscles to work in reverse because I had put them under insufficient tension, and on several occasions a small change of angle produced very large improvements. By the time I had finished construction, I had relearned several valuable lessons on forces and elasticity.

The best model I built was a simple one of an arm, with a 30cm long Shadow Muscle as the biceps and an elastic band as the triceps. I



spent several hours experimenting with this simple and easily constructed model and eventually, by adjusting the air valves and the timings of the program, produced a very smooth-running simulation of the arm lifting a pair of scissors.



The air can be supplied by a normal compressor and the valves allow for a wide range of adjustment of pressure, but I worked the system at home using a small air canister and connection for an air brush, and had few problems. The ease of use and flexibility of air supply could put this interesting area of pneumatics within the reach of primary schools without compressors.

This is a very interesting and exciting development in control technology and will strongly contribute to the use of pneumatics. I can see some very useful teaching points in the area of forces, angles and elasticity. The concept is a radical jump away from conventional pneumatics and makes a difficult area much easier to understand. It does not relate in any way to the industrial use of pneumatics but is very appropriate to the mechanisms used at school level. Well supported by an excellent manual, good software and sturdy equipment, Shadow Muscle gives the impression of careful thought and quality. A little more development in its use in a range of educational situations (and adaptation to other computer platforms and interfaces), and it provides a creative, pleasing and long needed innovation.

Shadow Muscle is available from Shadow Project, 357 Liverpool Road, London N1 1NL. Tel: 071-700 2487. The Shadow Kit costs £299 and includes control board, software, 11 muscles, sensors, switches, air pipes and 12v power supply.