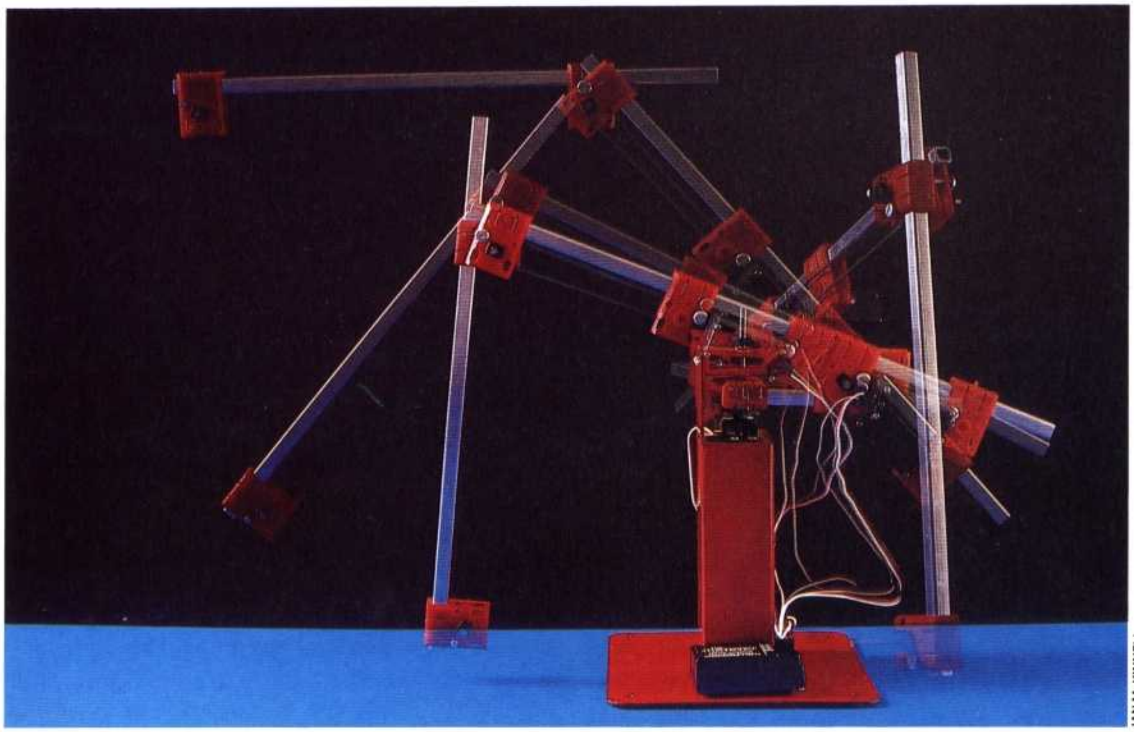
PUMPING IRON



Double Jointed
For the next decade, the archetypal robot will be the simple arm equipped with a variety of 'hands' for industrial, household and hobbyist use. Very few applications really require the self-propelled autonomous thinking machine of sci-fi myth, but a programmable semi-intelligent gripper is as significant a device as the plough or the telescope

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Having considered the various methods that are used to control robot movement, we now turn our attention to an equally important aspect of robot design — the control and movement of the robot's 'arm' and 'hand'.

A robot's effectiveness depends to a large degree on the precision with which it can manipulate objects. Many robots are used primarily for 'pick up and place' operations — moving components in a factory from one conveyor belt to another, for example. Thus, the design of the robot arm is of paramount importance.

In general, there are three requirements that must be considered. A system must be developed to describe the position of the arm at any time; the arm must have a 'skeleton'; and there must be a 'muscle' system that will actuate the arm and enable it to be controlled. The different ways in which these vital elements interact tend to dictate the overall appearance of robot arms. However, different types of arm may be roughly classified by considering the spatial methods used to describe the arm's exact position at any given time.

In our discussion of robot movement (see page 621), we described the Cartesian co-ordinate system. Using this method, the position of the robot on the floor was specified by means of two axes — x and y — at right angles to each other. The same principle can be applied to a robot arm, but, because an arm may move freely in three dimensions, we need to add another variable — z — to describe the arm's vertical position. Using these x, y and z co-ordinates, we can describe the position of the arm anywhere in space ('space' simply being the mathematical way of describing any open area).

It is possible to construct a robot arm that moves exactly along these three co-ordinates: the result will be something that looks a little like an overhead gantry crane that can move up/down, side-to-side, and forwards/backwards (or all three directions in combination). Arms like this are well suited to jobs in which work is done over some fixed area. For instance, the robot might have a workbench at which all its tasks are carried out, and, in this case, a Cartesian arm will be more than adequate. But this method does have its disadvantages. For example, such arms require a substantial frame, which makes them inflexible in applications away from the workbench.

Another method of describing the position of an arm uses cylindrical co-ordinates. To understand how these work, think of an empty tin can; you will realise that any position inside the can may be described by specifying its distance from the centre of the can (using a distance variable, r); how far around the can it is from some fixed point (using an angular variable, θ); and how far up the side of the can it is (using