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audio volume control by 'pushing' it up or 'pulling' it down.

All the other functions that one would expect in a well developed graphics package are also available. There are 'tools' for stretching and deforming lines by pulling them out between predetermined nodes (called 'rubber-banding'); for painting the blocks with one of the colours from the palette; and for magnifying small portions of the graphic image so that you can work in greater detail.

It is not so much the individual functions and capabilities of the Pinball Construction Set that are important, however, as its overall operating philosophy. Object oriented programming — where each operating element of the software package carries with it details of how it will work and how it interacts with any of the other objects or elements — lends itself to the production of programs that need very little computing experience or aptitude on the part of their users. This programming method will be used almost exclusively in the fifth generation of computers currently being developed. Object oriented programming is hailed as the most important breakthrough in the field of software science since high level languages were first introduced in the late fifties.

Most home computers have quite sufficient memory capacity and processing power for their user's needs. Any increase in that capacity and power is likely to be used to increase user friendliness. The truly remarkable thing about PCS is that it manages to achieve a high degree of user friendliness in only 48 Kbytes.

While object oriented programming applies itself readily to games and other graphics programs, it takes a little more programming ingenuity to introduce it into the field of business software. Though they do not use graphics as their

**Step By Step**

These four pictures show various stages in the construction of a pinball game. First of all the basic pieces are installed, then a polygon is added to form a central island. The polygon is deformed and painted orange. Finally, some of the objects are tied together (by means of an AND gate) so that a bonus is scored when all three have been activated

**Ready To Go**

Once the game is composed on the table it can be saved on disk. Because all the operating functions 'travel' with the table, the original software package isn't needed to re-run the program

main means of communication, spreadsheet packages (like Visicalc and Supercalc) are object oriented to a certain degree, in that each field or cell can contain both a piece of data and the relationships that define it.

Another example is Apple's Lisa system, which uses a 'mouse' to manoeuvre a pointer around the screen to select the program (represented by a graphic symbol) that you wish to run. The word processor, for example, is represented by a sheet of typing paper; the graph plotting program by a sheet of squared paper.

Perhaps the most fascinating of all its functions is the method Lisa uses to transfer data from one program to another. One of its 'Icons' (the name given to pictorial representations of functions on the screen) is a clipboard. If we wanted to take a small section of a spreadsheet and reproduce it as a graph, it is necessary only to define the window on the spreadsheet, transfer that window to the clipboard (which is a temporary storage area) and carry it across to the graph plotter program.

When we talked about arcade games (see page 221), we noted that there were a number of generically different types. PCS could well form a new category. It is tempting to suppose that the next step the home computer games industry will take will be the production of Maze and Chase Construction Sets, Space Invaders Construction Sets, and so on; at which point many games program writers could find themselves redundant.



CHRIS STEVENS

**Objective Outlook**

As well as being an intriguing and educational game, the Pinball Construction Set is a fine example of object oriented programming. In normal programming, the structure of the data is defined, and then program routines are written to manipulate this. In object oriented programming, the calculations and procedures are inseparable from the data. In the pinball program, moving the symbol for a pinball machine's flipper onto the board not only sets up the data (in this case, the shape of the flipper), but arranges for the associated routines to be set up to activate the flipper.

Object oriented programming lends itself to visual applications. Spreadsheets are another example: the field that displays a result will also contain the formula to get that result.

The current trend for business workstations that simulate the layout of items on a desktop also derives from the same idea. Pointing to an image of a piece of typing paper on the screen activates the word processor, whilst pointing to a miniature drawing of a filing cabinet will file the results away