Editorial

Realities of Virtual Reality

Alternative worlds have been presented for tens of millennia, in pictures and poetry and prose. By preserving and interpreting pasts and suggesting futures they enrich civilised life immeasurably, and equip each new generation with essential memes.¹

Picture technology of this century has added the motion and colour and sound experiences of cinema and television and, though far less successfully, stereo 3-D depth. Computer-based Virtual Reality (VR) is beginning to add the essentially different feature of observer–picture interaction. This promises explorations of imaginary worlds and aspects of real reality normally lying beyond our senses—such as experiencing quantum physics at the scale of molecules and atoms and fundamental particles. So far, however, goggle-vision VR leaves much to be desired. Its jerky low-resolution pictures can indeed put one off the whole enterprise. But what of its future? Are there essential limitations of VR? Specifically, will VR be useful for presenting science? This is a real question especially for those of us who are concerned with Hands-On Science Centres, such as the Exploratorium in San Francisco and the Exploratory here in Bristol, where the aim so far has been to provide children and the public with hands-on interactive experience of real phenomena and objects, to handle and explore with all the senses.

To consider VR's limitations, we may start by considering cinema and television. It is quite surprising that they work so well for they only provide fragmentary 2-D pictures, which are absurdly large or ridiculously small, and of course cannot be handled. Indeed, this has been so from the cave paintings of 30000 years ago and remains true of all 2-D pictures, without all that much gain for 3-D stereo. Cinema and TV have set such challenges to object and picture perception that it is remarkable how well they work, as rapid cutting from view to view and from scene to scene gives impossibly fast changes of scale and viewpoint, and where oneself is supposed to be. Between scenes we travel without benefit of proprioception—faster than light!² How are we able to follow these impossible sequences that we see in every film and TV programme? How do we appreciate the endings and beginnings of scenes, somehow knowing that shots belong to the same scene even though different objects are revealed?³ Film and video editing are intuitive arts, carried out with great skill, but with few explicit rules or appreciable theoretical understanding of the astonishing cognitive structuring that must be going on. Indeed, it is surprising that the perceptual skills of the audience are not studied more fully. There seems a great opportunity

¹ Richard Dawkins's name for social symbols and knowledge transferred through the generations—by analogy with genes. As individual experience does not affect genes (ie Lamarck was wrong), many kinds of memes are essential for civilisation.
² Film editing is a craft, not a science, and has received surprisingly little research. But see: Reisz and Millar (1968) for practical experience; for cognitive implications, Hochberg and Brooks (1978), and Hochberg (1987).
³ There may be a cost. There is a suggestion (from Moshe Aronson, Sackler Faculty of Medicine in Tel Aviv University) that prolonged watching of TV may be associated with brain damage, including Alzheimer's disease. This is attributed to rapidly changing scenes, and to emotions aroused without corresponding action (Vines 1993). The evidence may not be strong but it is a possibility to be considered.
opportunity here for perceptual research, and no doubt interactive Virtual Reality offers further possibilities for studying powers of perception and its limitations.\(^{(4)}\)

Now, emerging in mid-shot, is the computer-based technology of interactive goggles Virtual Reality, which provides 3-D stereo vision with a small cathode ray tube for each eye in the goggles of a helmet. One can walk around in the computer-generated world, as one's position is monitored from an aerial on the helmet. One can 'touch' and 'pick up' objects with the DataGloves which have sensors detecting movements of the fingers. The whole system—3-D goggles, DataGloves, and computer—is known as the Reality Engine. Explorers of Virtual Reality are Cybernauts. It may become possible to introduce other people into the computer world: friends, teachers, lovers. It is beginning to be possible to introduce one's self—to meet as in a Free Will interactive mirror.

The writer Howard Rheingold (1991) describes his first experience of VR:

“When a cybernaut shifts his gaze or waves her hand, the reality engine weaves the data stream from the cybernaut's sensors together with updated depictions of the digitized virtual world into the whole cloth of a three-dimensional simulation. The computer engine, however, contributes only part of the VR system. Cyberspace is a co-operative production of the microchip-based reality engine sitting on the floor of the laboratory and the neural engine riding in my cranium.”

As we know, cooperation with the 'neural cranium engine' is vital for all perception, and the cooperation is greatly enhanced by hand–eye interaction—for Real and no doubt for Virtual Reality. But, at the time of writing, VR has a long way to go before it is convincing or pleasant in spite of the cranium engine, as there are disturbing anomalies, not encountered in normal reality. Compared with computer graphics, where the computer can spend as long as necessary for calculating the edges and shadows and highlights and so on of a static picture, interactive VR is sadly unimpressive. And, curiously, the defects of VR are far more annoying than the more obvious limitations of drawings and paintings. Evidently VR promises much more than it provides. But this situation might change with technical advances. Oddly, it would be better with less (as for drawings and paintings) or more technical sophistication.

What are current snags?

First: there is the inherent paradox of disparity for 3-D presented on flat screens, for the eyes are accommodated at one distance though features of the scene are presented as lying at various distances, through the horizontal disparities of 'corresponding points'. This is acceptable for a few minutes; but rapidly becomes confusing, to the point of headache and nausea. Second: limitations of computer processing speed impose a highly undesirable delay between any commanded motion and resulting change of the picture. As shown several years ago by Smith and Smith (1962), small time-delays are far more damaging to perception than even gross spatial transforms, and remain so after lengthy and, so far as we know, infinite experience. In practice the computing delays of VR can be literally sickening, and irritating also is the present lack of resolution ofoggle displays—so poor the observer is technically blind.

Let's suppose that both these snags are overcome. Fortunes await inventors who succeed. If and when they are overcome, how useful will VR be, let's say for presenting 'hands-on' science? Will the pictures of VR ever rival real objects for interactive exploration, teaching, and learning? To consider this, we may start with a distinction between film (or video) and programmed pictures—though this distinction is being blurred with digital processing of photographic or video pictures. The distinction is

\(^{(4)}\)Jonathan Miller and Julian Hochberg (Hochberg 1987a, 1987b) do appreciate that there is much to be learned here. Karel Reisz and Gavin Millar (1968) present an authoritative handbook for film makers.
that a programmer is free to include or leave out anything: for there are no restraints from reality. The observer does not know what selection or fiction-generation has been made. For example, consider the use of a thermometer in a science centre. A real mercury thermometer has properties the programmer may miss or misrepresent: When heated, the mercury column will initially fall—because the glass tube will expand faster than the mercury. This is not so for an alcohol thermometer as the specific heat of alcohol is so much less. More important: the mercury will have a downgoing meniscus at its contact with the glass, which is not so for alcohol. The difference is due to very interesting molecular forces which are well worth observing. On film or video, this may be seen and be accepted as genuine; but hardly so for programmed pictures. For will the programmer notice and appreciate such subtle but important differences? And, if represented, how is the viewer going to know it is correct, or indeed incorrect?

Actual objects have the restraints of physics. These may, or may not, be represented in VR. The snag is: the observer does not know what to believe. On the other hand—just because VR can extend restraints such as those of physics—it may represent things that are true but not normally observable. This is an enormous plus. The snag is that their truth must be taken on trust.

There is nothing essentially new in this. A drawing may represent truth or falsity, generally a complex mixture. Writing may simply miss out details which inadvertently are wrong in drawings, for gaps are better tolerated in prose than pictures, so prose can be less misleading.

We are used to this, and much of scholarship is challenging truth of other scholars and how they present their facts and ideas. This involves making explicit what is pictured or conveyed, producing lively and often fruitful debate. Here there are rules and politenesses that preserve the vitality and integrity of scholarship. But it takes time—many years—to get into this. It is not available for children, or the uninitiated learning science. It is here that VR partial-yet-seeming-true pictures seem most dangerous. Yet it is just here that VR is most likely to be used and trusted.

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