Virtual art

Art that draws you in

C. DAVIES

Virtually there: computers allow viewers to immerse themselves in Charlotte Davies' *Osmose*.

Computer-generated virtual reality is a new form of art only in terms of its medium, according to art historian Oliver Grau of the Humboldt University in Berlin, Germany. In his highly original book *Virtual Art: From Illusion to Immersion* (MIT Press, $45), Grau argues that artists have been using a variety of techniques to immerse observers within their works for millennia.

The earliest trick simply involved physically surrounding the viewer with images. The frescos covering all four walls in a room in the Villa dei Misteri at Pompei, Italy, created in about 60 BC, draw observers into a 360° depiction of the preparations for a cult ritual. Those adorning a room in Livia's Villa at Prima Porta, dating from about 20 BC, create a 360° illusion of a garden. Post-antiquity, the frescos in the Chambre du Cerf (Chamber of the Stag) at Pope Clement VI's palace in Avignon, France, from 1343, place the observer at the centre of a hunting scene.

Mathematical perspective was the visual trick of the Renaissance. It is epitomized by the sixteenth-century Salle delle prospettive (Chamber of Perspectives) at the Villa Farnesina in Rome, the walls of which depict a columned hall. Between the pillars of the portico appears a view looking out onto the city and to the hills beyond.

Peepshow boxes — the forerunners of the stereoscope and the head-mounted display — first appeared in the eighteenth century, and in 1787 Robert Barker patented his hugely successful process for producing panoramic views on circular canvasses in correct perspective for observers standing at the centre. The techniques of cinematography and computing simply extended the opportunities for artists to immerse observers in an illusory world, according to Grau.

In the 1990s, the developers of virtual reality began to hire artists to assist them. Among these was Charlotte Davies, whose *Osmose*, shown here, is a total immersion in the fabric of the living Earth — rocks, roots, trees and leaves. It is is a product of her relationship with the Canadian software company Softimage.

But digital artworks are vulnerable to extinction as the operating systems on which they are based become redundant. Grau is cooperating on an international, interdisciplinary level with art academies and research laboratories to document two decades of computer-based art, much of which already cannot be shown. He has, for example, built a database of virtual art, a cataloguing project that is part technological and part art-historical, and is intended to support preservation efforts. *Osmose* is one of hundreds of works that will become publicly accessible through this database in the coming months. **Alison Abbott**

The resulting system is more ordered than the original homogeneous gas, and so has lower entropy. Furthermore, by making the trapdoor sufficiently lightweight, the demon can operate it by expending an arbitrarily small amount of energy. Thus, a naive analysis suggests that Maxwell's demon reduces the total entropy of the system, violating the second law of thermodynamics.

This paradox was resolved in 1982, when physicist Charles Bennett, building on earlier work by others, notably Rolf Landauer, showed that this analysis fails to take into account an entropy cost associated with the information acquired by the demon when it observes the velocities of molecules approaching the trapdoor. The cost is an entropic price paid when the demon erases its record of these observations. Remarkably, when this cost is taken into account, the violation of the second law is found to be illusory and the paradox is resolved.

A more recent example of information taking a surprising central role in fundamental science is a bold idea known as the holographic principle. Roughly speaking, this states that the correct way to describe a region of space-time is not through a description of fields and forces in the bulk of the volume, as is conventionally done, but through a theory whose elements are defined on the surface of the region. The motivation for the principle comes in part from results about the thermodynamics of black holes suggesting that the information content of a black hole is proportional to its surface area, not its volume. Some researchers hope that the holographic principle will help lead to a quantum theory of gravity, much as Einstein's principle of equivalence helped to motivate the general theory of relativity.

These and other examples illustrate the intellectual ferment associated with the role of information in fundamental science. It is against this backdrop that Hans Christian von Baeyer's elegant popular book is set.

The book's most appealing feature is its focus on big questions. What is information? What role does information play in fundamental physics? Where else in science does information play a critical role? And what common themes link these areas? Von Baeyer approaches these questions from many angles, giving us a flavour of some of the most interesting answers currently being offered.

There is a nice balance between accepted science and speculative ideas. For example, the standard theory of information, proposed by Claude Shannon in the 1940s, is introduced early in the book. However, von Baeyer admits that Shannon's theory has some shortcomings, and provides a flavour of several other approaches to developing information theories, notably quantum information theory.

Von Baeyer discusses many fascinating topics in a tour that is broad but not deep, taking in genetics, bioinformatics, quantum computation, the foundations of quantum mechanics, and black-hole entropy. He faces, and on the whole overcomes reasonably well, the difficulty faced by popular science writers of needing to simplify without misleading. However, I did notice several unfortunate minor errors of fact.

In summary, von Baeyer has provided an accessible and engaging overview of the emerging role of information as a fundamental building block in science. ■

Michael A. Nielsen is in the School of Information Technology and Electrical Engineering and the School of Physical Sciences, University of Queensland, Queensland 4072, Australia.